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TECHNICAL MANUAL

TRANSPORTABILITY GUIDANCE FOR SAFE TRANSPORT OF RADIOACTIVE MATERIALS

HEADQUARTERS, DEPARTMENT OF THE ARMY
JUNE 1989

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Technical Manual
No. 55-315

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC *23 June 1989*

TECHNICAL MANUAL
TRANSPORTABILITY GUIDANCE
FOR
SAFE TRANSPORT OF RADIOACTIVE MATERIALS

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CHAPTER 1
INTRODUCTION

1-1. Purpose and Scope

a. This manual provides guidance for Army personnel concerned with the safe transport of radioactive materials *other than weapons*. It is designed mainly to help interested persons identify the pertinent provisions of applicable Federal and Army regulations. Nuclear weapons and components shipments are covered in AR 55-203 and AR 50-5. Unwanted radioactive material is covered in TM 3-261 and AR 385-11.

b. This manual covers those Federal and Army regulations that apply to shipments of radioactive materials, other than weapons, by commercial and military transport and the United States mail. It describes in nontechnical language, so far as possible, the limitations, exemptions, standards, procedures, and precautions applying to packing, packaging, marking, labeling, documentation, loading, transport, and unloading of radioactive materials. To facilitate use of the manual, each guidance chapter has a checklist, which is cross-referenced to applicable detailed coverage in the text.

c. Persons responsible for shipping radioactive materials must have access to Federal and Army regulations and be familiar with the complete regulations and applicable carriers' tariffs to comply with the latest changes and revisions.

d. The masculine gender, when used in this manual, represents both the masculine and feminine genders unless otherwise specifically stated.

1-2. Reporting of Recommendations and Changes

Users of this publication are encouraged to recommend changes and submit comments for its improvement. Comments should be prepared on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded to Commander, Military Traffic Management Command Transportation Engineering Agency, ATTN: MTT-TRA (W. Dixon), PO Box 6276, Newport News, VA 23606-0276. (Electrically transmitted messages should be addressed to: CDR MTMCTEA FT EUSTIS VA //MTT-TR//.)

1-3. Applicability

The policy of the Department of the Army, as stated in AR 385-11, is to comply with all Federal, State, and local transportation laws, ordinances, and regulations. The procedures outlined in this manual apply to military shipments within or greater than that required in interstate commerce. In oversea areas, the policy of the Department of the Army is to conform with the requirements of the nation(s) in which the shipment moves and to provide a level of protection equal to that required in the United States.

1-4. Application of Federal Regulations

a. Availability of Regulations. Copies of Federal regulations pertaining to transport of radioactive material are available at installation JAG offices and from installation transportation officers.

b. Citation of Regulations. The approved citation of the *Code of Federal Regulations* is CFR. Thus the citation "49 CFR 1.1" refers to section 1.1 of title 49. The references used in this manual and the applicable CFR citation are as follows:

(1) Title 10, 10 CFR.
(2) Title 39, 39 CFR.
(3) Title 49, 49 CFR.

1-5. Responsibilities

a. The Nuclear Regulatory Commission (NRC). The NRC approves the packaging of fissile materials and large quantities of radioactive materials. Pertinent CFR references are:

(1) 10 CFR 20.
(2) 10 CFR 71.
(3) 10 CFR 73.

b. The Department of Transportation (DOT). The DOT (including the Federal Aviation Administration and the United States Coast Guard) regulates interstate shipment and/or movement of radioactive materials by all transport modes (except the US mail). Pertinent reference is 49 CFR 171-178. (Commercial versions of these regulations are contained in Bureau of Explosives Tariff BOE 6000-A.)

(1) *The Federal Aviation Administration (FAA).* The FAA regulates movements of radioactive mate-

rials in civil aircraft. Its regulations are published in 49 CFR. TM 38-250 contains requirements for shipment by military aircraft. Other references are:

(*a*) 49 CFR 171.

(*b*) Official Air Transport Restricted Articles Tariff No. 6-Series, Agent - C.C. Squire, General Manager.

(*c*) AR 95-27.

(2) *The United States Coast Guard (USCG).* The USCG regulates the movement of radioactive materials by water. Its requirements are published in 49 CFR 176.

c. The United States Postal Service (USPS). The USPS regulates the mailing of radioactive materials. Postal requirements are published in US Postal Service Publication 52.

d. The Director of Safety, DCSPER. The Director of Safety coordinates with, and furnishes guidance to, Army staff agencies and commanders of major Army commands on all safety-policy matters on the transport of radioactive materials other than weapons. Pertinent reference is AR 385-11.

e. The Commander, Military Traffic Management Command (MTMC). The Commander, MTMC acts as the authorized representative of the military services in arranging for DOT special permits (para 4-19). MTMC also provides transportability monitoring, evaluation, and guidance.

f. The Commanding Officer at the Point of Origin. The origin shipper arranges for movement of radioactive materials according to AR 55-16, AR 55-162, AR 385-11, and AR 55-355; properly packages, labels, loads, and blocks and braces the cargo; prepares shipping documents; inspects and surveys vehicles and cargo; notifies consignee of pending shipment; and arranges for technical escort when required. Also, he coordinates with civil law enforcement agencies for assistance in expediting movement of such shipments. In oversea areas, if status of forces agreements contain different transport requirements, the more stringent requirements will be followed.

g. The Commanding Officer at the Receiving Agency. The receiving activity accepts, offloads, surveys, inspects, and acknowledges receipt of the shipment.

CHAPTER 2
DEFINITIONS

Unless otherwise specified, the following definitions will be used throughout this manual (49 CFR 173.403).

2-1. A_1

The A_1 quantity is the maximum activity of special-form radioactive material permitted in a Type A package.

2-2. A_2

The A_2 quantity is the maximum activity of radioactive material other than special-form or low specific activity (LSA) radioactive material permitted in a Type A package.

2-3. Atomic Number

The atomic number is the number of protons in the nucleus of an atom; also, the number of orbital electrons surrounding the nucleus of a neutral atom (symbol: Z).

2-4. Bequerel (Bq)

A unit, in the international system of units (si), of measurement of radioactivity equal to one transformation per second. It is expressed in terms of disintegrations per second.

2-5. Closed Transport Vehicle

A closed transport vehicle is a vehicle equipped with a securely attached exterior enclosure that, during normal transport, restricts the access of unauthorized persons to the cargo space containing the radioactive materials. The enclosure may be temporary or permanent, and in the case of packaged materials, may be of the see-through type, and must limit access from the top, sides, and ends.

2-6. Consignee

The consignee is the person or company that receives the shipment.

2-7. Consignor

The consignor is the person or company that makes the shipment.

2-8. Containment System

The containment system is the packaging components intended to retain the radioactive contents during transport.

2-9. Conveyance

Conveyance means:

a. Transport by public highway or rail; any transport vehicle or large freight container.

b. Transport by any vessel, or any hold compartment, or defined deck area of a vessel.

c. Transport by any aircraft.

2-10. Critical Mass

Critical mass is that amount or mass of active material that will just support a sustaining chain reaction.

2-11. Criticality

Criticality is the condition of being critical. A reactor is described as having reached criticality when the chain reaction starts.

2-12. Curie (Ci)

Curie is a measurement unit of radioactivity. One curie equals 3.7×10^{10} nuclear disintegrations per second.

One microcurie (u Ci) = $(10^{-6})(3.7 \times 10^{10})$ disintegrations per second (dps) = 3.7×10^{4} dps.

2-13. Depleted Uranium

Depleted uranium is uranium that contains less uranium-235 than the naturally occurring distribution of uranium isotopes.

2-14. Design

Design is the description of a special-form material, a package, or a packaging that enables those items to be fully identified. The description may include specifications, engineering drawings, reports showing compliance with regulatory requirements, and other relevant documentation.

2-15. Enriched Uranium

Enriched uranium is uranium that contains more uranium-235 than the naturally occurring distribution of uranium isotopes.

2-16. Exclusive Use

Exclusive use (also called sole use or full load) is the sole use of a vehicle by a single consignor and for which all initial, intermediate, and final loading and unloading are carried out under the direction of the consignor or consignee. Any loading or unloading must be performed by personnel with radiological training and resources appropriate for safe handling of the consignment. Specific instructions for maintaining exclusive-use shipment controls must be issued in writing and included with the shipping papers the consignor provides to the carrier.

2-17. Fissile Material (49 CFR 173.403(j))

a. Fissile Material. Any material consisting of or containing one or more fissile radionuclides. Fissile radionuclides are plutonium-238, plutonium-239, plutonium-241, uranium-233, and uranium-235. Neither natural nor depleted uranium is fissile material. Fissile materials are classified according to the controls needed to provide nuclear criticality safety during transport; they are as indicated in *b*, *c*, and *d* below.

(1) Uranium-235 exists only in combination with various percentages of uranium-234 and uranium-238. Fissile radioactive material, as applied to uranium-235, refers to the amount of uranium-235 actually contained in the total quantity of uranium being transported.

(2) Radioactive material may consist of mixtures of fissile and nonfissile radionuclides. Fissile radioactive material refers to the amount of plutonium-238, plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination thereof actually contained in the mixture. The radioactivity of the mixture consists of the total activity of both the fissile and nonfissile radionuclides. All mixtures containing fissile material will be subject to 49 CFR 173.451 through 173.459.

b. Fissile Class I. This class consists of packages that may be transported in unlimited numbers and in any arrangement and that require no nuclear criticality safety controls during transport. For nuclear criticality safety control, a transport index is not assigned to Fissile Class I packages. However, the external radiation levels may require a transport index.

c. Fissile Class II. This class consists of packages that may be transported together in any arrangement but in limited numbers, not to exceed a total transport index of 50. For nuclear criticality safety control, individual packages may have a transport index of not less than 0.1 and not more than 10. However, the external radiation levels may require a higher transport index but not to exceed 10. Such packages require no nuclear criticality safety control by the shipper during transport.

d. Fissile Class III. This class consists of packages that do not meet the requirements of Fissile Class I or II and that are controlled to provide nuclear criticality safety transport by special arrangements between the shipper and the carrier.

2-18. Gray (Gy)

A gray is a unit, in the international system of units, of absorbed dose which is equal to one joule per kilogram. One Gy is equivalent to 100 rad.

2-19. Highway Route Controlled Quantity (49 CFR 173.403(l))

A highway route controlled quantity is the quantity within a single package which exceeds:

a. 3,000 times the A_1 value of the radionuclides as specified in 49 CFR 173.433 for special-form material;

b. 3,000 times the A_2 value of the radionuclide as specified in 49 CFR 173.433 for normal-form radioactive material; or

c. 3,000 curies, whichever is least.

2-20. Licensed Material

Licensed material is source material, special nuclear material, or by-product material received, possessed, used, or transferred under a general or specific license issued by the NRC.

2-21. Limited Quantity

A limited quantity is the quantity of radioactive material not to exceed the material package limits, as specified in table 4-7 of this manual, and that conforms to the requirements of limited quantities of radioactive materials specified in 49 CFR 173.421 through 173.424.

2-22. Low Specific Activity (LSA) Material

LSA material is any of the following:

a. Uranium or thorium ores and physical or chemical concentrates of those ores.

b. Uniradiated natural or depleted uranium or uniradiated natural thorium.

c. Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries per milliliter.

d. Material in which the radioactivity is essentially uniformly distributed and the estimated average concentration of contents does not exceed:

(1) 0.0001 millicurie per gram of radionuclides for which the A_2 quantity is not more than 0.05 curie;

(2) 0.0005 millicurie per gram of radionuclides for which the A_2 quantity is more than 0.05 curie, but not more than 1 curie; or

(3) 0.3 millicurie per gram of radionuclides for which the quantity is more than 1 curie.

e. Objects of nonradioactive material externally contaminated with radioactive material provided the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of 1 square meter, does not exceed 0.0001 millicurie (220,000 disintegrations per minute) per square centimeter of radionuclides for which the A_2 quantity is not more than 0.05 curie, or 0.001 millicurie (2,200,000 disintegrations per minute) per square centimeter for other radionuclides.

2-23. Multilateral Approval

Multilateral approval is approval by both the appropriate competent authority of the country of origin and of each country throughout or into which the shipment is to be moved. This definition does not imply approval from countries over which radioactive materials are carried in aircraft, if no stop is scheduled in that country.

2-24. Nonfixed Radioactive Contamination (49 CFR 173.403(r) and 49 CFR 173.443)

Nonfixed (removable) radioactive contamination is radioactive contamination that can be readily removed by wiping a surface with an absorbent material. Such contamination is insignificant if it does not exceed the limits specified in paragraph 3-9 of this manual.

2-25. Normal-Form Radioactive Material

Normal-form radioactive material is radioactive material that does not qualify as "special-form radioactive material." See paragraph 2-42 below.

2-26. Package

A package is the packaging together with its radioactive contents as presented for transport.

2-27. Packaging

A packaging is the assembly of components necessary to ensure compliance with packaging requirements. The packaging may consist of thermal insulation, radiation shielding, and one or more receptacles, absorbent materials, spacing structures, and devices for cooling or absorbing mechanical shocks. Sometimes, the conveyance, tiedown system, and auxiliary equipment may be designated as part of the packaging.

2-28. Radiation Absorbed Dose (rad)

The rad is a measure of any ionizing radiation to body tissue in terms of the energy absorbed per unit mass in grams of the tissue. One rad is a dose that corresponds to the absorption of 100 ergs per gram of body tissue.

2-29. Radiation Hazard

Radiation hazard may be divided into two categories, internal and external, depending on the location of the radiation source with respect to the person being exposed. Internal hazard means the radiation source is inside the body; external hazard means the radiation source is outside the body. Since all radionuclides present an internal hazard, every effort must be made to keep radioactive material from entering the body.

2-30. Radiation Level

Radiation level is the radiation dose-equivalent rate expressed in millirem per hour (mrem/h). Neutron flux densities may be converted into radiation levels according to table 2-1.

2-31. Radiation Types

Radioactive material produces four major types of radiation, each of which is described below.

a. Alpha Radiation. Alpha radiation is a positively charged particle emitted from the nucleus of a radioactive atom. Physically, an alpha particle is the same as a helium atom nucleus moving at high speed. Alpha radiation is the least penetrating of the common types of radiation (compared on the basis of the same energy), but it is characterized by a high ionizing capability. Therefore, alpha particles represent practically no hazard outside of the body, but alpha-emitting materials are extremely dangerous if absorbed into the body.

b. Beta Radiation. Beta radiation is a negatively or positively charged particle emitted from the nucleus of an atom. Physically, the beta particle is the same as an electron moving at a high speed. Compared on the basis of the same energy, beta particles are more penetrating than alpha particles but are less penetrating than gamma rays or x-rays. Therefore, beta particles are more hazardous from outside the body than are alpha particles. Beta-emitting materials are also extremely dangerous if absorbed into the body.

Table 2-1. Neutron Flux Densities to be Regarded as Equivalent to a Radiation Level of 1 Millirem per Hour (mrem/h) *

Energy of neutron	Flux density equivalent to 1 mrem/h (Neutrons per square centimeter per second) ($n/cm^2/s$)
Thermal	268.0
5 keV	228.0
20 keV	112.0
100 keV	32.0
500 keV	12.0
1 MeV	7.2
5 MeV	7.2
10 MeV	6.8

* Flux densities equivalent for energies between those listed above may be obtained by linear interpolation.

c. Gamma Radiation. Gamma radiation is high-energy electromagnetic radiation similar to x-rays. Compared on the basis of the same energy, gamma rays are more penetrating than alpha or beta particles.

d. Neutron Radiation. The intensity of neutron radiation is expressed in terms of "neutron flux", which is the number of neutrons passing through a unit area in a unit time. A neutron is an uncharged particle present in all atomic nuclei except those of light hydrogen. Compared on the basis of the same energy, neutrons are more penetrating than beta particles and may be more or less penetrating than x-rays or gamma rays, depending upon the neutron cross section of the interacting medium.

2-32. Radiation Units

Radiation units are indirect measures of the quantity of radiation. In this manual, radiation units are the radiation absorbed dose (rad), roentgen (R), and roentgen equivalent man (rem).

2-33. Radioactive Article

A radioactive article is any manufactured instrument or article that has radioactive material as a component part.

2-34. Radioactive Contents

Radioactive contents are the radioactive materials, together with any contaminated liquids or gases, within the package.

2-35. Radioactive Decay Chain

A radioactive decay chain is a succession of nuclides, each of which transforms into the next until a stable nuclide is formed. The first member of the series is called the parent, the intermediate members are called the daughters, and the final member is called the end product.

2-36. Radioactive Material

Radioactive material is any material with a specific activity greater than 0.002 microcurie per gram (uCi/g) (see para 2-43 below).

2-37. Radionuclide

A radionuclide is a species of atom, characterized by the number of protons and neutrons in its nucleus, that exhibits the property of radioactivity.

2-38. Radionuclides, A_1 and A_2 Values

Table 2-2 lists the A_1 and A_2 values for radionuclides.

2-39. Roentgen (R)

A roentgen is that quantity of X or gamma radiation that will produce, as a result of ionization, one electrostatic unit of electricity, of either sign, in 1cc of dry air at 0°C and standard atmosphere pressure. The mass of 1cc of dry air under the standard conditions specified is 0.001293 gram. One roentgen is equivalent to energy absorption of 86.9 ergs per gram in air. A milliroentgen (mR) is one-thousandth (10^{-3}) of a roentgen.

2-40. Roentgen Equivalent Man (rem)

The rem is a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one roentgen of x-rays. (One millirem (mrem) equals one-thousandth (10^{-3}) of a rem.) The relations of the rem to other dose units depend on the biological effect under consideration and the conditions of irradiation. For this manual, any of the following is considered to equal a dose of 1 rem.

Table 2-2. Table of A_1 and A_2 Values for Radionuclides

Symbol of radionuclide	Element and atomic number	A_1 (Ci) special form	A_2 (Ci) normal form
^{227}Ac	Actinium (89)	1000	0.003
^{228}Ac		10	4
^{105}Ag	Silver (47)	40	40
^{110m}Ag		7	7
^{111}Ag		100	20
^{241}Am	Americium (95)[1]	8	0.008
^{243}Am		8	0.008
^{37}Ar (compressed or uncompressed)	Argon (18)	1000	1000
^{41}Ar (uncompressed)		20	20
^{41}Ar (compressed)		1	1
^{73}As	Arsenic (33)	1000	400
^{74}As		20	20
^{76}As		10	10
^{77}As		300	20
^{211}At	Astatine (85)	200	7
^{193}Au	Gold (79)	200	200
^{196}Au		30	30
^{198}Au		40	20
^{199}Au		200	25
^{131}Ba	Barium (56)	40	40
^{133}Ba		40	10
^{140}Ba		20	20
^{7}Be	Beryllium (4)	300	300
^{206}Bi	Bismuth (83)	5	5
^{207}Bi		10	10
^{210}Bi (RaE)		100	4
^{212}Bi		6	6
^{249}Bk	Berkelium (97)	1000	1
^{77}Br	Bromine (35)	70	25
^{82}Br		6	6
^{11}c	Carbon (6)	20	20
^{14}c		1000	60
^{45}Ca	Calcium (20)	1000	25
^{47}Ca		20	20
^{109}Cd	Cadmium (48)	1000	70
^{115m}Cd		30	30
^{115}Cd		80	20
^{139}Ce	Cerium (58)	100	100
^{141}Ce		300	25
^{143}Ce		60	20
^{144}Ce		10	7
^{249}Cf	Californium (98)	2	0.002
^{250}Cf		7	0.007
^{252}Cf		2	0.009
^{36}Cl	Chlorine (17)	300	10
^{38}Cl		10	10
^{242}Cm	Curium (96)	200	0.2
^{243}Cm		9	0.009

See footnotes at end of table.

Table 2-2. Continued

Symbol of radionuclide	Element and atomic number	A_1 (Ci) special form	A_2 (Ci) normal form
^{244}Cm		10	0.01
^{245}Cm		6	0.006
^{246}Cm		6	0.006
^{56}Co	Cobalt (27)	5	5
^{57}Co		90	90
^{58m}Co		1000	1000
^{58}Co		20	20
^{60}Co		7	7
^{51}Cr	Chromium (24)	600	600
^{129}Cs	Cesium (55)	40	40
^{131}Cs		1000	1000
^{134m}Cs		1000	10
^{134}Cs		10	10
^{135}Cs		1000	25
^{136}Cs		7	7
^{137}Cs		30	10
^{64}Cu	Copper (29)	80	25
^{67}Cu		200	25
^{165}Dy	Dysprosium (66)	100	20
^{166}Dy		1000	200
^{169}Er	Erbium (68)	1000	25
^{171}Er		50	20
^{152m}Eu	Europium (63)	30	30
^{152}Eu		20	10
^{154}Eu		10	5
^{155}Eu		400	60
^{18}F	Flourine (9)	20	20
^{52}Fe	Iron (26)	5	5
^{55}Fe		1000	1000
^{59}Fe		10	10
^{67}Ga	Gallium (31)	100	100
^{68}Ga		20	20
^{72}Ga		7	7
^{153}Gd	Gadolinium (64)	200	100
^{159}Gd		300	20
^{68}Ge	Germanium (32)	20	10
^{71}Ge		1000	1000
^{3}H	Hydrogen (1) See T-Tritium		
^{181}Hf	Hafnium (72)	30	25
^{197m}Hg	Mercury (80)	200	200
^{197}Hg		200	200
^{203}Hg		80	25
^{166}Ho	Holmium (67)	30	30
^{123}I	Iodine (53)	50	50
^{125}I		1000	70
^{126}I		40	10
^{129}I		1000	2
^{131}I		40	10

See footnotes at end of table.

Table 2-2. Continued

Symbol of radionuclide	Element and atomic number	A_1 (Ci) special form	A_2 (Ci) normal form
^{132}I		7	7
^{133}I		30	10
^{134}I		8	8
^{135}I		10	10
^{111}In	Indium (49)	30	25
^{113m}In		60	60
^{114m}In		30	20
^{115m}In		100	20
^{190}Ir	Iridium (77)	10	10
^{192}Ir		20	10
^{194}Ir		10	10
^{42}K	Potassium (19)	10	10
^{43}K		20	10
^{85m}Kr (uncompressed)	Krypton (36)	100	100
^{85m}Kr (compressed)		3	3
^{85}Kr (uncompressed)		1000	1000
^{85}Kr (compressed)		5	5
^{87}Kr (uncompressed)		20	20
^{87}Kr (compressed)		0.6	0.6
^{140}La	Lanthanum (57)	30	30
LSA	Low specific activity material - see 49 CFR 173.403		
^{177}Lu	Lutetium (71)	300	25
MFP	Mixed fission products	10	0.4
^{28}Mg	Magnesium (12)	6	6
^{52}Mn	Manganese (25)	5	5
^{54}Mn		20	20
^{56}Mn		5	5
^{99}Mo	Molybdenum (42)	100	20
^{13}N	Nitrogen (7)	20	10
^{22}Na	Sodium (11)	8	8
^{24}Na		5	5
^{93m}Nb	Niobium (41)	1000	200
^{95}Nb		20	20
^{97}Nb		20	20
^{147}Nd	Neodymium (60)	100	20
^{149}Nd		30	20
^{59}Ni	Nickel (28)	1000	900
^{63}Ni		1000	100
^{65}Ni		10	10
^{237}Np	Neptunium (93)	5	0.005
^{239}Np		200	25
^{185}Os	Osmium (76)	20	20
^{191}Os		600	200
^{191m}Os		200	200
^{193}Os		100	20
^{32}P	Phosphorus (15)	30	30
^{230}Pa	Protactinium (91)	20	0.8

See footnotes at end of table.

Table 2-2. Continued

Symbol of radionuclide	Element and atomic number	A_1 (Ci) special form	A_2 (Ci) normal form
^{231}Pa		2	0.002
^{233}Pa		100	100
^{201}Pb	Lead (82)	20	20
^{210}Pb		100	0.2
^{212}Pb		6	5
^{103}Pd	Palladium (46)	1000	700
^{109}Pd		100	20
^{147}Pm	Promethium (61)	1000	25
^{149}Pm		100	20
^{210}Po	Polonium (84)	200	0.2
^{142}Pr	Praseodymium (59)	10	10
^{143}Pr		300	20
^{191}Pt	Platinum (78)	100	100
^{193m}Pt		200	200
^{197m}Pt		300	20
^{197}Pt		300	20
^{238}Pu	Plutonium (94)[1]	3	0.003
^{239}Pu		2	0.002
^{240}Pu		2	0.002
^{241}Pu		1000	0.1
^{242}Pu		3	0.003
^{223}Ra	Radium (88)	50	0.2
^{224}Ra		6	0.5
^{226}Ra		10	0.05
^{228}Ra		10	0.05
^{81}Rb	Rubidium (37)	30	25
^{86}Rb		30	30
^{87}Rb		Unlimited	Unlimited
Rb (natural)		Unlimited	Unlimited
^{186}Re	Rhenium (75)	100	20
^{187}Re		Unlimited	Unlimited
^{188}Re		10	10
Re (natural)		Unlimited	Unlimited
^{103m}Rh	Rhodium (45)	1000	1000
^{105}Rh		200	25
^{222}Rn	Radon (86)	10	2
^{97}Ru	Ruthenium (44)	80	80
^{103}Ru		30	25
^{105}Ru		20	20
^{106}Ru		10	7
^{35}S	Sulphur (16)	1000	60
^{122}Sb	Antimony (51)	30	30
^{124}Sp		5	5
^{125}Sb		40	25
^{46}Sc	Scandium (21)	8	8
^{47}Sc		200	20
^{48}Sc		5	5
^{75}Se	Selenium (34)	40	40

See footnotes at end of table.

Table 2-2. Continued

Symbol of radionuclide	Element and atomic number	A_1 (Ci) special form	A_2 (Ci) normal form
^{31}Si	Silicon (14)	100	20
^{147}Sm	Samarium (62)	Unlimited	Unlimited
^{151}Sm		1000	90
^{153}Sm		300	20
^{113}Sn	Tin (50)	60	60
^{119m}Sn		100	100
^{125}Sn		10	10
^{85m}Sr	Strontium (38)	80	80
^{85}Sr		30	30
^{87m}Sr		50	50
^{89}Sr		100	10
^{90}Sr		10	0.4
^{91}Sr		10	10
^{92}Sr		10	10
T (uncompressed)	Tritium (1)	1000	1000
T (compressed)		1000	1000
T (activated luminous paint		1000	1000
T (absorbed on solid carrier)		1000	1000
T (tritiated water)		1000	1000
T (other forms)		20	20
^{182}Ta	Tantalum (73)	20	20
^{160}Tb	Terbium (65)	20	10
^{96m}Tc	Technetium (43)	1000	1000
^{96}Tc		6	6
^{97m}Tc		1000	200
^{97}Tc		1000	400
^{99m}Tc		100	100
^{99}Tc		1000	25
^{125m}Te	Tellurium (52)	1000	100
^{127m}Te		300	20
^{127}Te		300	20
^{129m}Te		30	10
^{129}Te		100	20
^{131m}Te		10	10
^{132}Te		7	7
^{227}Th	Thorium (90)	200	0.2
^{228}Th		6	0.008
^{230}Th		3	0.003
^{231}Th		1000	25
^{232}Th		Unlimited	Unlimited
^{234}Th		10	10
Th (natural)		Unlimited	Unlimited
Th (irradiated)[2]			
^{200}Tl	Thallium (81)	20	20
^{201}Tl		200	200
^{202}Tl		40	40

See footnotes at end of table.

Table 2-2. Continued

Symbol of radionuclide	Element and atomic number	A_1 (Ci) special form	A_2 (Ci) normal form
^{204}Tl		300	10
^{170}Tm	Thulium (69)	300	10
^{171}Tm		1000	100
^{230}U	Uranium (92)	100	0.1
^{232}U		30	0.03
^{233}U		100	0.1
^{234}U		100	0.1
^{235}U		100	0.2
^{236}U		200	0.2
^{238}U		Unlimited	Unlimited
U (natural)		Unlimited	Unlimited
U (enriched)			
20%		Unlimited	Unlimited
20% or greater		100	0.1
U (depleted)		Unlimited	Unlimited
U (irradiated)[3]			
^{48}V	Vanadium (23)	6	6
^{181}W	Tungsten (74)	200	100
^{185}W		1000	25
^{187}W		40	20
^{127}Xe (uncompressed)	Xenon (54)	70	70
^{127}Xe (compressed)		5	5
^{131m}Xe (compressed)		10	10
^{131m}Xe (uncompressed)		100	100
^{133}Xe (uncompressed)		1000	1000
^{133}Xe (compressed)		5	5
^{135}Xe (uncompressed)		70	70
^{135}Xe (compressed)		2	2
^{87}Y	Yttrium (39)	20	20
^{90}Y		10	10
^{91m}Y		30	30
^{91}Y		30	30
^{92}Y		10	10
^{93}Y		10	10
^{169}Yb	Ytterbium (70)	80	80
^{175}Yb		400	25
^{65}Zn	Zinc (30)	30	30
^{69m}Zn		40	20
^{69}Zn		300	20
^{93}Zr	Zirconium (40)	1000	200
^{95}Zr		20	20
^{97}Zr		20	20

[1] For shipments solely within the United States, the A_1 value is 20 curies for americium and plutonium contained in Am-Be or Pu-Be neutron sources or in nuclear-powered pacemakers.
[2] The values of A_1 and A_2 must be calculated according to the procedure specified in 49 CFR 173.433, taking into account the activity of the fission products and of the uranium-233 as well as that of the thorium.
[3] The values of A_1 and A_2 must be calculated according to the procedure specified in 49 CFR 173.433, taking into account the activity of the fission products and plutonium isotopes as well as that of the uranium.

a. An exposure of 1 R because of X or gamma radiation.

b. A dose of 1 rad because of X or gamma radiation.

c. A dose of 0.1 rad because of neutron or high-energy radiation.

d. A dose of 0.05 rad because of particles heavier than protons and with sufficient energy to reach the lens of the eyes.

e. If enough information exists to provide a reasonable estimate of the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equal to 1 rem may be estimated from table 2-3.

2-41. Sievert (Sr)

A sievert is a unit, in the international system, of dose equivalence which is equal to 1 joule per kilogram. One Sv is equal to 100 rem.

2-42. Special-Form Radioactive Material

Special-form radioactive material is any radioactive material that meets the following conditions:

a. It either is a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule.

b. The piece or capsule has at least one dimension that is 5 millimeters (0.197 inch) or greater.

c. It satisfies the test requirements for special-form radioactive materials outlined in 49 CFR 173.469. Special-form encapsulations designed according to the requirements in effect on 30 June 1983 and constructed before 1 July 1985 may be used. Those designed or constructed after 30 June 1985 must meet the requirements outlined in this paragraph.

2-43. Specific Activity

The specific activity of a radionuclide is the activity per unit mass of that radionuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the activity per unit mass of the material.

2-44. Specification Container

Specification containers are approved containers or packages whose specifications are included in 49 CFR 178. These containers are of two types - Type A and Type B packagings.

2-45. Specially Approved Containers

Specially approved containers are those containers that have been specially approved by the DOT. Each shipment using a specially approved container is subject to the conditions specified in the pertinent permit or approval.

2-46. Transport Index

The transport index is the dimensionless number (rounded up to the first decimal place) placed on the label of a package to designate the degree of control the carrier must exercise during transport. The transport index is determined as follows:

a. The number rounded up to the first decimal place expressing the maximum radiation level in millirem per hour at 1 meter (3.3 feet) from the external surface of the package.

b. For Fissile Class II packages or Fissile Class III packages, the number expressing the maximum radiation level at 1 meter (3.3 feet) from the external surface of the package, or the number obtained

Table 2-3. Neutron Flux Dose Equivalents

Neutron energy (MeV)	No. neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm^2)	Average flux to deliver 100 mrem in 40 hours (neutrons/cm^2 per second)
Thermal	970×10^6	680
0.0001	720×10^6	500
0.005	820×10^6	570
0.02	400×10^6	280
0.1	120×10^6	80
0.5	43×10^6	30
1.0	26×10^6	18
2.5	29×10^6	20
5.0	26×10^6	18
7.5	24×10^6	17
10	24×10^6	17
10 to 30	14×10^6	10

by dividing 50 by the allowable number of packages that may be transported together, whichever is larger.

2-47. Transport Vehicle

A transport vehicle is the railcar, motor truck, trailer, or other highway vehicle used to transport radioactive material. Aircraft and watercraft are not included.

2-48. Type A Package

A Type A package is a Type A packaging plus its limited radioactive contents. A Type A package does not require competent authority approval, since its contents are limited to A_1 or A_2 quantities.

2-49. Type A Packaging

A Type A packaging is a packaging designed to retain the integrity of containment and shielding required under normal transport conditions as shown by the tests set forth in Type A packaging tests (49 CFR 173.465) or in the additional tests for Type A packagings designed for liquids and gases (49 CFR 173.466) as appropriate.

2-50. Type B Package

A Type B package is a Type B packaging plus its radioactive contents.

2-51. Type B Packaging

Type B packaging is a packaging designed to retain the integrity of containment and shielding required when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR 71.

2-52. Type B(M) Package

A Type B(M) package is a Type B packaging, plus its radioactive contents that, for international shipments, requires multilateral approval of the package design and may require approval of the conditions of shipment. Type B(M) packages are those Type B package designs that have a maximum normal operating pressure gauge with a range of more than 7 kilograms per square centimeter (100 pounds per square inch) or a relief device that would allow the release of radioactive material into the environment under the hypothetical accident conditions specified in 10 CFR 71.

2-53. Type B(U) Package

A Type B(U) package is a Type B packaging plus its radioactive contents that, for international shipments, requires unilateral approval only of the package design and of any storage provisions that may be necessary for heat dissipation.

2-54. Types A and B Quantities

Types A and B quantities are the quantities of activity contained in Type A or B packages as outlined in chapters 3 and 4.

2-55. Uncompressed Gas

For this manual, uncompressed gas is gas at a pressure not exceeding the ambient atmospheric pressure at the time and place the containment system is closed. All other radioactive gases are considered to be compressed.

2-56. Unilateral Approval

Unilateral approval is approval by the competent authority of the country of origin only.

2-57. Uniradiated Thorium

Uniradiated thorium is thorium containing not more than 10^{-7} grams of uranium-233 per gram of thorium-232.

2-58. Uniradiated Uranium

Uniradiated uranium is uranium containing not more than 10^{-6} grams of plutonium per gram of uranium-235 and a fission product activity of not more than 0.25 millicurie of fission products per gram of uranium-235.

2-59. Used Solely For Vehicles

Used solely for transport vehicles are vehicles that can be used by more than one consignor at one time. However, the material being shipped must be identical on that and on each subsequent shipment.

CHAPTER 3
LIMITS

3-1. General Quantity Limits for Packages

The quantity limits for the Type A and Type B packages are expressed in physical and activity limits.

a. Physical Limits (49 CFR 173.412).

(1) Type A packaging is physically restricted to:

(*a*) Temperature range of −40°C (−40°F) to 70°C (158°F).

(*b*) The contents of the package must be physically and chemically compatible under irradiation and compatible with its by-products produced by decomposition.

(*c*) Packaging shall meet all design requirements outlined in chapter 4 of this manual.

(2) Type B packaging is physically restricted to the limits outlined in 10 CFR 71.

(3) Type B(M) packaging is a Type B packaging that has a normal operating pressure gauge of more than 7 kilograms per square centimeter (100 psi) or a relief device that would allow the release of radioactive material to the environment under the hypothetical accident conditions specified in 10 CFR 71 (49 CFR 173.403(ee)). These packaging limits are outlined in 10 CFR 71.

(4) Type B(U) packaging is a type B packaging that, during international shipments, requires unilateral approval only of the package design and of any stowage provisions that may be necessary for heat dissipation (49 CFR 173.403(ff)). These packaging limits are also outlined in 10 CFR 71.

b. Activity Limits (49 CFR 173.431).

(1) A Type A package shall not contain a quantity of radioactive materials greater than A_1 or A_2 as listed in table 2-2. For radioactive material not listed in this table, see 49 CFR 173.433.

(2) The limits of activity contained in a Type B, B(U), or B(M) package are those prescribed in 49 CFR 173.416 or the applicable approval certificate under 49 CFR 173.471 or 49 CFR 173.473 (49 CFR 173.431).

(3) Exceptions to these requirements may be requested through command channels to Deputy Chief of Staff for Personnel (DCSPER), ATTN: DAPE-HRS, Washington, DC 20310–0300 (commercial (202) 695-7291), with a copy to Commander, Army Materiel Command, ATTN: AMCSF-P, 5001 Eisenhower Ave, Alexandria, VA 22333–0001 (commercial (202) 274-9475).

CAUTION

Explosives containing radioactive materials or with radioactive components will not be transported except under special arrangements according to the conditions and specifications approved by appropriate regulatory agencies (see para 4-19).

3-2. Limits for Shipment by United States Mail (US Postal Service Publication 52)

Any package of radioactive material that must bear the Department of Transportation's "Radioactive White-I, Yellow-II, or Yellow-III" label or that contains quantities in excess of those authorized in USPS Publication 6 is non-mailable (Domestic Mail Manual 124.37). See chapter 14 of this manual for additional details.

3-3. Limits for Shipment by Aircraft, Rail, and Vessel

a. Aircraft. Limits for aircraft shipments differ for passenger-carrying, cargo, and exclusive-use cargo aircraft. They also differ within each of three categories of aircraft based on certain parameters. Chapter 10 discusses these limits in detail.

b. Rail. Except for exclusive-use shipments, the limits for shipments in any railcar or stored at any single location is a total transport index of 50, which is derived by adding the transport indexes shown on each package. See chapter 12 for additional details.

c. Vessel. The limits for vessel shipments vary based on several parameters. These limits are detailed in chapter 13.

3-4. Limits for Shipment by Passenger-Carrying Motor Vehicles, Transport Vehicles, Exclusive-Use Vehicles, and Exclusive-Use Closed Transport Vehicles

a. Passenger-Carrying Motor Vehicles. No radioactive material requiring labels may be transported in

or on any for-hire motor vehicle carrying passengers, except where no other practicable means of transport are available. If passenger-carrying motor vehicles are used, packages of radioactive materials must be stored only in the truck or baggage compartment of the vehicle, not in any compartment occupied by persons. Packages of radioactive materials must be handled and placed in the vehicle as prescribed in paragraph 11-12 of this manual (49 CFR 177.842). The maximum gross weight of the shipment will not exceed 100 pounds (49 CFR 177.870).

b. Transport Vehicles (49 CFR 173.459). Except as provided in *c* and *d* below, a transport index of not more than 50, determined by adding the transport indexes shown on each package, may be shipped in any transport vehicle (para 2-47 and 49 CFR 173.459 (*a*)). Mixing of Fissile Classes I and II packages is permissible.

c. Exclusive-Use Vehicle (49 CFR 177.842 and 49 CFR 173.459(c)3). A transport index of not more than 50 may be transported in an exclusive-use vehicle. However, under the conditions prescribed in 49 CFR 173.457 and the provisions of paragraph 4-14 of this manual, the transport index for nuclear criticality control purposes shall not exceed 100 for all packages in a shipment.

d. Exclusive-Use Closed Transport Vehicles. Packaged radioactive materials may be shipped in an exclusive-use closed transport vehicle following the restriction outlined in *c* above. Unpackaged (bulk) LSA materials shall be shipped only in exclusive-use closed transport vehicles. However, bulk shipments of LSA materials are limited to the following:

(1) Uranium or thorium ores and physical or chemical concentrates of those ores.

(2) Uranium metal or natural thorium metal, or alloys of these materials.

(3) Materials of low radioactive concentration. The average estimated radioactivity concentration shall not exceed 0.001 millicurie per gram and the contribution from materials with an A_2 value of less than 0.05 curie does not exceed 1 percent of the total radioactivity. See table 2-2 for the A_2 values.

(4) Objects of nonradioactive material that are externally contaminated with radioactive material. The radioactive material shall not be readily dispersible, and the surface contamination over a 1 square meter average shall not exceed 0.001 millicurie per square centimeter for all radionuclides of which the A_2 value is less than 0.05 or 0.001 millicurie per square centimeter of other radionuclides. Such objects must be suitably wrapped or enclosed.

3-5. Thermal Limits (49 CFR 173.442)

Each package of radioactive material shall be designed, constructed, and loaded so that:

a. The heat the radioactive contents generate within the package will not, at any time during transport, affect the integrity of the package.

b. The temperature of the accessible external surfaces of the loaded package will not, based on still air in the shade at an ambient temperature of 38°C (100°F), exceed either:

(1) 50°C (122°F) in other than an exclusive use shipment, or

(2) 82°C (180°F) in an exclusive use shipment.

3-6. Limits for Transport of Fissile Class III Materials (49 CFR 173.457)

Fissile Class III materials shall be shipped to provide:

a. Nuclear criticality safety.

b. Exclusive-use conveyance if moved over public highway or rail.

c. An escort to provide administrative controls if transported by aircraft.

d. If moved over public highway, the conveyance shall have no other packages of radioactive material that must bear one of the following labels: POISON, FLAMMABLE LIQUID, FLAMMABLE SOLID, DANGEROUS WHEN WET, CORROSIVE, CARGO AIRCRAFT ONLY, MAGNETIZED MATERIAL, BUNG, ETIOLOGIC AGENTS, and EMPTY.

e. See paragraph 4-15 for additional details.

3-7. Limits for Transport of Mixed Fissile Material Packages (49 CFR 173.459)

Shipments of mixed fissile material packages shall adhere to the following limits:

a. The total transport index shall not exceed 50.

b. For Fissile Class II packages shipped under the exclusive-use provisions, the transport index, which is calculated for nuclear criticality control purposes, shall not exceed 10 for any single package nor a total of 50 for the conveyance.

c. Fissile Class II packages may be shipped with an external radiation level greater than 10 millirems per hour at 1 meter (3.3 feet). Also, they may be combined with other packages of the same or different designs in a Fissile Class III shipment if the provisions of 49 CFR 173.459(c) are met.

d. A shipment of Fissile Class III packages may be combined with other packages of the same or different design when each package has been assigned a transport index for nuclear criticality control purposes according to Fissile Class II criteria, and may be combined with Fissile Class III shipment if under the provisions of 49 CFR 173.459(d).

e. For exceptions regarding shipments of fissile materials, see 49 CFR 173.453.

3-8. Determination of Nonfixed Radioactive Contamination (49 CFR 173.433(a))

The level of nonfixed radioactive contamination may be determined by wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements shall be taken in the most appropriate locations to yield a representative assessment of the nonfixed contamination levels. The amount of radioactivity measured on any single wiping material, when averaged over the surface wiped, is the contamination level.

3-9. Contamination Limits for Conveyance of Low Specific Activity Materials

Dependent on particular parameters, low specific activity (LSA) materials may be transported by exclusive-use conveyances or by conveyances that do not meet exclusive use requirements. (49 CFR 173.443 and 173.425 (general), 49 CFR 176.715(a) (vessel), 49 CFR 175.705 (aircraft), 49 CFR 174.715 (rail))

a. Conveyances That do not Meet the Requirements of Exclusive Use or Exclusive-Use Closed Transport Vehicles but are Used to Transport Low Specific Activity Materials. Any transport vehicle, vessel hold, vessel compartment, deck area, aircraft, or railcar used for transporting LSA materials must be surveyed after each use with appropriate radiation detection instruments. The conveyance must not be used again until the radiation dose rate at any accessible surface is not more than 0.5 millirem per hour and the removable (non-fixed) radioactive surface contamination, as measured per paragraph 3-8 above is insignificant.

(1) Unpackaged (bulk) LSA materials shall be transported only in exclusive-use closed transport vehicles (49 CFR 173.425(c)).

(2) Packaged LSA materials that are excepted from specification packaging, marking, and labeling may not be transported by aircraft (49 CFR 175.705 (b)).

(3) Aircraft used routinely for transporting radioactive materials shall be periodically checked for radioactive contamination. The frequency of checks shall be related to the likelihood of contamination and the extent to which radioactive materials are carried (49 CFR 175.705(a)).

b. Exclusive-Use Conveyances, Including Transport Vehicles (49 CFR 173.443(c)), Railcars (49 CFR 174.715(a)), Vessels (49 CFR 176.715(a)), and Aircraft (49 CFR 175.705). Exclusive-use conveyances shall be surveyed after each use with appropriate radiation detection instruments. They shall not be used again until the radiation dose rate at each accessible surface is 0.5 millirem, or less, per hour and the removable (nonfixed) radioactive surface contamination is insignificant.

c. Exclusive-Use Closed Transport Vehicles and Exclusive-Use Railcars (49 CFR 173.443(d)). These conveyances shall be surveyed after each use with appropriate radiation detection instruments. They shall not be used again until the radiation dose rate at each accessible surface does not exceed 10 millirems per hour at the surface or 2 millirems per hour at 1 meter (3.3 feet) from the surface. These conveyances must be stenciled with the words "FOR RADIOACTIVE MATERIALS USE ONLY"in lettering at least 3 inches (76 millimeters) high in a conspicuous place on both exterior sides of the vehicle. The vehicles must remain closed except for loading or unloading.

3-10. Contamination Limits for Conveyances Used to Transport Radioactive Materials Other Than Low Specific Activity Materials

The contamination limits for conveyances used to transport radioactive materials other than LSA materials are the same as those limits outlined in paragraph 3-9 above.

3-11. Contamination Limits of Packaging

The level of nonfixed (removable) radioactive contamination on the external surfaces of each package offered for shipment shall be kept as low as practicable. However, there are three different categories for the contamination limits of packaging.

a. Based on the methods outlined in paragraph 3-8, the contamination level on the external surfaces of the package shall not exceed the limits listed in table 3-1. Other assessment methods of equal or greater efficiency may be used if they are according to 49 CFR 173.443(a).

b. On the external surfaces of packages transported in exclusive-use shipments by rail or only on public highways, the contamination level at the beginning of transport shall not exceed the limits listed in table 3-1. However, during tansport, the contamination level on the outer surfaces may increase, but it shall not be allowed to exceed 10 times the limits listed in table 3-1. The exclusive-use railcar or transport vehicle must meet the requirements outlined in paragraph 3-9*b* above.

c. Packages shipped in closed transport vehicles and only over public highways may have exterior surface contamination levels up to 10 times the limits listed in table 3-1. The exclusive-use closed transport vehicle must meet the requirements listed in paragraph 3-9c above.

Table 3-1. Removable External Radioactive Contamination - Wipe Limits

Contaminant	Maximum permissible limits	
	uCi/cm^2	dpm/cm^2
Beta-Gamma emitting radionuclides; all radionuclides with half-lives less than 10 days; natural uranium; natural thorium; uranium-235; uranium-238; thorium-232; thorium-228, and thorium-230 when contained in ores or physical concentrates	10^{-5}	22
All other alpha emitting radionuclides	10^{-}	2.2

3-12. Contamination Limits for Empty Packaging

The contamination limits for empty radioactive materials packaging are specified as external surface and internal contamination limits of the package. Both limits must be achieved.

CAUTION

All shipping containers will be transported as if fully loaded with ionizing radiation materials until determined otherwise by competent authority.

a. External Surface Contamination Limits (49 CFR 173.443(a)). The level of nonfixed (removable) radioactive contamination on the external surface shall not, at any time during transport, exceed the limits given in table 3-1.

b. Internal Contamination Limits (49 CFR 173.427). Any empty radioactive materials package must maintain the external marking and labeling requirements outlined in chapter 4 unless the following conditions are met.

(1) The internal contamination does not exceed 10 times the limits specified in table 3-1.

(2) The radiation level at any point on the external surface of the package does not exceed 0.5 millirem per hour.

(3) The package does not contain more than 15 grams of uranium-235, except as provided in 49 CFR 173.424.

(4) The packaging is unimpaired and is securely closed so no leakage of radioactive material will occur under normal transport conditions.

(5) Any labels previously applied are removed, obliterated, or covered, and the "Empty" label is affixed to the packaging as specified in chapter 5.

(6) The package is prepared for shipment as specified in the additional requirements for excepted radioactive materials, per 49 CFR 173.421-1.

3-13. Radiation-Level Limits

a. Except as provided in *b* below, each package of radioactive materials offered for transport shall be designed and prepared for shipment so that, under normal conditions, the radiation level does not exceed 200 millirems per hour at any point on the external surface of the package and the transport index does not exceed 10.

b. A package that exceeds the radiation levels specified in *a* above shall be transported only by exclusive-use shipment (para 2-16). Also, during transport, the radiation levels must not exceed the following:

(1) 200 millirems per hour (2 millisieverts per hour) on the external surface of the package unless the following conditions are met, in which case the limit is 1000 millirems per hour (10 millisieverts per hour).

(*a*) The shipment is made in a closed transport vehicle.

(*b*) The package is secured within the vehicle so that it cannot move during transport.

(*c*) No loading or unloading operations occur between the start and end of the transportation.

(2) 200 millirems per hour (2 millisieverts per hour) at any point 2 meters (6.6 feet) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flatbed-style vehicle, at any point on the vertical planes projected by the outer edges of the vehicle, on the upper surface of the load (or enclosure if used), and on the lower external surface of the vehicle.

(3) 10 millirems per hour (0.1 millisievert per hour) at any point 2 meters (6.6 feet) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flatbed-style vehicle, at any point 2 meters (6.6 feet) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle).

(4) 2 millirems per hour (0.02 millisievert per hour) in any space personnel normally occupy. However, this provision does not apply to private carriers if exposed personnel under their control wear radiation dosimetry devices and operate under the provisions of a State or Federally regulated radiation protection program.

c. For shipments made under the provisions of *b* above, the shipper shall provide, to the carrier,

specific written instructions for maintaining the exclusive-use shipment controls. The instructions shall be included with the shipping papers.

d. Packages exceeding the radiation level or transport index prescribed in *a* above shall not be transported by aircraft. See paragraph 3-3*a* for more information.

e. The written instructions required for exclusive-use shipments must be sufficient so that, when followed, they will cause the carrier to avoid actions that would unnecessarily delay delivery or result in increased radiation levels or exposures.

3-14. Dose Limitations, Nonoccupational Exposure (AR 40-14)

Nonoccupational exposure of any person, such as a passenger, crew member, stevedore, and so forth (also animal cargo), who do not normally work with ionization radiation will not exceed 0.5 rem in any calendar year.

NOTE

Normally transportation workers and handlers should be considered as subject to this nonoccupational dose limitation.

3-15. Dose Limitations, Occupational Exposure (AR 40-14)

Exposure to ionizing radiation because of duties in direct support of the handling or use of radioactive materials will not exceed the following limits:

a. The accumulated dose equivalent of radiation to the whole body, head and trunk, active blood-forming organs, gonads, or lens of the eye will not exceed:

(1) 1.25 rems in any calendar quarter, nor

(2) 5 rems in any calendar year.

b. The accumulated dose equivalent of radiation to the skin of the whole body (other than hands or forearms), cornea of the eye, and bone will not exceed:

(1) 7.50 rems in any calendar quarter, nor

(2) 50 rems in any calendar year.

c. The accumulated dose equivalent of radiation to the hands and wrists or the feet and ankles will not exceed:

(1) 18.75 rems in any calendar quarter, nor

(2) 50 rems in any calendar year.

d. The accumulated dose equivalent of radiation to the forearms will not exceed:

(1) 10 rems in any calendar quarter, nor

(2) 30 rems in any calendar year.

e. The accumulated dose equivalent of radiation to the thyroid, other organs, tissues, and organ system will not exceed:

(1) 5 rems in any calendar quarter, nor

(2) 15 rems in any calendar year.

3-16. Special Dose Limitations for Persons Under 18 Years Old and Pregnant Women (AR 40-14)

Persons under 18 years old and women known to be pregnant will not be exposed to a whole body dose equivalent that exceeds:

a. 2 millirems in any one hour, nor

b. 100 millirems in any seven consecutive days, nor

c. 500 millirems in any calendar year for persons under 18 years old, nor

d. 500 millirems during the entire gestation period for pregnant women, nor

e. More than 10 percent of the values in paragraphs 3-15*a* through *e* above for other areas of the body.

3-17. Dose Limitations and Relationships to Packaging

The dose limitations in paragraphs 3-14 through 3-16 above will not be interpreted as requiring the shipper - that is, consignor - to reduce the radiation levels for packages of radioactive material below the permissible levels given in chapter 4 of this manual.

3-18. Compliance With Dose Rate and Contamination Limits

To ensure compliance with the dose rates and contamination limits, each package shall be checked with appropriate and properly calibrated instruments. This check will be done when materials are accepted for shipment and also before they are loaded for movement and released to the carrier. The package check will ensure that the dose rate and contamination level are below the maximum permissible transport limits. If the instruments, or competent people to use them, are not available in the installation transportation officer's (ITO) office, the ITO will request this evaluation from the installation health physicist, radiation protection officer, or other competent person. The person making the radiation-level check will certify that the contamination level and dose rate are below the permissible standards. This certificate will become a part of the shipping document.

CHAPTER 4
PACKAGING AND SHIELDING

Section I. GENERAL

4-1. Purpose of Packaging and Shielding

The purpose of proper packaging and shielding is to prevent radiological contamination of the environment and to reduce the intensity of radiation emitted from the package. To minimize the exposure to personnel, quantity and radiation unit limits must not be exceeded, and except under emergency conditions, separation distances must not be less than those given. Improper packaging might result in the escape of radionuclides. Such an escape presents the possibility of subjecting personnel to an internal hazard and this must be avoided. Therefore, the need for careful adherence to container and package specifications is stressed.

4-2. Organization and Use

a. Section II of this chapter contains the rules and regulations pertaining to packaging and shielding requirements. These requirements are referenced to appropriate sections of the *Code of Federal Regulations* and other applicable regulations.

b. Section III contains a checklist of considerations and actions necessary to ensure that the regulatory requirements are met. This checklist is cross-referenced to the appropriate paragraphs of section II.

Section II. REGULATORY REQUIREMENTS AND PROCEDURES

4-3. Standard Requirements for all Packages (49 CFR 173.24)

a. Each package used for shipping hazardous materials under provisions of this manual shall be so designed and constructed, and its contents so limited, that, under normal transport conditions:

(1) The release of hazardous materials to the environment will not be significant:

(2) The effectiveness of the packaging will not be substantially reduced; and

(3) The package will contain no mixture of gases or vapors that could, through any credible spontaneous increase of heat or pressure, or through an explosion, greatly reduce the effectiveness of the packaging.

b. Materials for which specific packaging is not given in this manual must be securely packaged in strong, tight packages that meet the applicable requirements of this section.

c. Packaging used for shipping of hazardous materials under provisions of this manual shall, unless otherwise specified or exempted, meet the applicable design and construction criteria listed in paragraphs 4-4 through 4-17.

4-4. General Packaging and Shipment Requirements (49 CFR 173.411)

a. Unless otherwise specified, all shipments of radioactive materials must meet all design requirements for standard packages (49 CFR 173.24), general packages (49 CFR 173.411), Type A packages (49 CFR 173.412), and Type B packages (49 CFR 173.413), as well as those requirements outlined in this chapter.

b. The outside of each Type A package must include a feature, such as a seal, that is not readily breakable and that, while intact, will be evidence that the package has not been illicitly opened.

c. The smallest outside dimension of any package must be 4 or more inches.

d. Each radioactive material must be packaged in a packaging that has been designed to maintain shielding efficiency and leak tightness, so that, under normal transport conditions, no radioactive material will be released. If necessary, additional suitable inside packaging must be used. Each package must be able to meet the additional design requirements for Type A packages (49 CFR 173.[illegible]). Internal bracing or cushioning, where used, must be

adequate to assure that, under normal transport conditions, the distance from the inner container or radioactive material to the outside wall of the package remains within the limits on which the package design was based. Also, the radiation dose rate outside the package must not exceed the transport index shown on the label. Inner shield closures must be positively secured to prevent loss of the contents.

e. The packaging must be designed, constructed, and loaded so that, during transport:

(1) The heat the radioactive materials generate within the package will not, at any time, affect the efficiency of the package under normal transport conditions, and

(2) The temperature of the accessible external surfaces of the package, when fully loaded, will not exceed 122°F in the shade based on still air at ambient temperature. If the package is shipped in a transport vehicle consigned for the sole use of the consignor, the maximum accessible external surface temperature shall be 180°F.

f. Pyrophoric materials, besides the packaging prescribed in this section, must also meet the packaging requirements of 49 CFR 173.418. Pyrophoric radioactive liquids may not be shipped by air.

g. Liquid radioactive materials in Type A quantities must be packaged within a leak- and corrosion-resistant container vessel. Also:

(1) The packaging must be adequate to prevent loss or dispersal of the radioactive contents from the inner container if the package were subjected to the 9-meter (30-foot) drop test prescribed in 49 CFR 173.463; and either

(2) Enough absorbent material must be provided to absorb at least twice the volume of radioactive liquid contents. The absorbent material may be located outside the radiation shield only if it can be shown that, if the radioactive liquid contents were taken up by the absorbent material, the resultant dose rate at the surface of the package would not exceed 1000 millirems per hour, or

(3) A secondary leak- and corrosion-resistant container must be provided to retain the radioactive contents under the normal transport conditions prescribed in 49 CFR 173.412(n) based on the failure of the inner main container vessel.

h. The removable radioactive surface contamination on the exterior of the package must not be significant (para 3-11).

i. Except for shipments described in *j* below, all radioactive materials must be packaged in suitable packaging (shielded, if necessary) so that:

(1) At any time during the normal transport conditions, the radiation dose rate does not exceed 200 millirems per hour at any point on the external surface of the package, and

(2) The transport index does not exceed 10.

j. Packages for which the radiation dose rate exceeds the limits in *i* above, but does not exceed, at any time during transport, any of the limits specified in paragraph 3-4*c*, may be shipped in a transport vehicle (except aircraft) that has been consigned as exclusive use (sole use). If such shipment is made, the carrier must provide the shipper with specific instructions for maintaining the exclusive-use shipment controls. Such instructions must be included with the shipping papers. Dose rate limits for such shipments are outlined in chapter 3 of this manual.

k. Packages consigned for export are also subject to the regulations of the foreign governments involved in the shipment (see 49 CFR 174.473). (The regulations of the International Atomic Energy Agency (IAEA) are used by most foreign governments.)

l. Before the first shipment of any package, the shipper shall determine, by examination or appropriate test, that:

(1) The packaging meets the specified quality of design and construction, and

(2) The effectiveness of the shielding and containment and, where necessary, the heat transfer characteristics of the package are within the limits applicable to or specified for the package design.

m. Before each shipment of any package, the shipper shall ensure, by examination or appropriate test, that:

(1) The package is proper for the contents to be shipped.

(2) The packaging is unimpaired except for superficial marks.

(3) Each closure device of the packaging, including any required gasket, is properly installed and secured and is free of defects.

(4) For a fissile material, any moderator and neutron absorber, if required, is present and in proper condition.

(5) Any special instructions for filling, closing, and preparing the package for shipment have been followed.

(6) Each closure, valve, and any other opening of the containment system through which the radioactive content might escape is properly closed and sealed.

(7) Each package containing liquid in excess of a Type A quantity and destined for air shipment is tested to show that it is leak tight under an ambient atmospheric pressure differential of at least 0.5 atmosphere (absolute) (7.3 psia or 0.5 kg/cm^2); the test may be conducted on the entire containment system,

as appropriate, to determine compliance with the requirement.

(8) If the maximum normal operating pressure of a package is likely to exceed 0.35 kilogram per square centimeter (gauge), the internal pressure of the container will not exceed the design pressure.

(9) External radiation and contamination levels are within the allowable limits.

n. No person may offer for transport a package of radioactive materials until the temperature of the packaging system has reached equilibrium (see also *e* above) unless, for the specific contents, he has ascertained that the maximum applicable surface temperature limits cannot be exceeded.

o. No person may offer for transport aboard a passenger-carrying aircraft any radioactive material unless that material is intended for use in, or incident to, research or medical diagnosis or treatment, or is excepted under the provisions of 49 CFR 175.10.

4-5. Quality Assurance Requirements (10 CFR 71.101 and 71.137)

Each activity engaged in design, fabrication, assembly, testing, maintenance, or use of packaging shall establish an approved quality assurance program to be applied to the activity's function(s). Quality assurance program requirements are further explained in chapter 9.

4-6. Requirements for Specification Containers (49 CFR 173.24)

a. Each specification container must be marked as follows:

(1) In an unobstructed area with letters and numerals identifying the container specification; for example, DOT-1A, DOT-17E-304HT, or DOT-23G40 (see 49 CFR 178.0-2).

(2) With the name and address or symbol of the person making the mark specified in (1) above. Symbol letters, if used, must be registered with the Bureau of Explosives. Duplicate symbols are not authorized.

(3) With stamped, embossed, burned, printed, or other markings to provide adequate accessibility, permanency, and contract so as to be readily apparent and understood.

(4) With at least 1/2-inch-high letters and numeral, unless otherwise specified.

b. Packaging that does not comply with the applicable specifications listed in 49 CFR 178 and 179 must not be marked to show such compliance (see 49 CFR 178.0-2 and 179.1).

c. For specification containers, compliance with the applicable specifications in 49 CFR 178 and 179 shall be required in all details, except as otherwise provided in this paragraph.

4-7. Materials Used in Packaging (49 CFR 173.24)

a. Steel used shall be low-carbon, commercial quality. Stainless, open hearth, electric, basic oxygen, or other similar quality steels are acceptable. Steel sheets of specified gauges shall comply with table 4-1.

b. Lumber used shall be well seasoned, commercially dry, and free from decay, loose knots, knots that would interfere with nailing, and other defects that would materially lessen the strength.

c. Welding and brazing shall be performed in a workmanlike manner using suitable and appropriate techniques, materials, and equipment.

d. Packaging materials and contents shall be such that no significant chemical or galvanic reaction will occur among any of the materials in the package.

e. Closures shall be adequate to prevent inadvertent leakage of the contents under normal transport conditions. Gasketed closures shall be fitted with gaskets of efficient material that will not be deteriorated by the contents of the container.

f. Nails, staples, and other metallic devices shall not protrude into the outer packaging in such a manner as to be likely to cause failures.

g. The nature and thickness of the packaging shall be such that, during transport, friction will not generate any heat likely to decrease the chemical stability of the contents.

h. The polyethylene used must be of a type compatible with the lading and must not be permeable to an extent that a hazardous condition could be caused during transport and handling.

Table 4-1. Sheet Steel Dimensions

Gauge No.	Nominal thickness (in.)	Minimum thickness (in.)
12	0.1046	0.0946
13	0.0897	0.0817
14	0.0747	0.0677
15	0.0673	0.0603
16	0.0598	0.0533
17	0.0538	0.0478
18	0.0478	0.0428
19	0.0418	0.0378
20	0.0359	0.0324
22	0.0299	0.0269
23	0.0269	0.0239
24	0.0239	0.0209
26	0.0179	0.0159
28	0.0149	0.0129
30	0.0120	0.0110

4-8. Requirements for Special-Form Radioactive Materials (49 CFR 173.403(z))

To qualify as special-form radioactive material, the radioactive material must satisfy the following conditions:

a. The material either is a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule.

b. The piece or capsule has at least one dimension that is 5 millimeters (0.197 inch) or greater.

c. It satisfies the test requirements of 49 CFR 173.469.

4-9. Standards for Type A Packaging (49 CFR 173.403(gg))

a. Type A packaging must be designed and constructed to meet the design requirements for general packages (49 CFR 173.411) and for Type A packages (49 CFR 173.412).

b. Type A packaging must also meet the test requirements outlined in 49 CFR 173.463, 173.465, and 173.466.

4-10. Evaluation of Hypothetical Accident Conditions (10 CFR 71.73)

To determine their cumulative effect on a package or on an array of packages, hypothetical accident conditions will be evaluated based on sequential application of the test specified in 10 CFR 71.73.

4-11. Requirements for Packaging of Normal-Form Radioactive Materials (49 CFR 173.415 and 173.416)

a. Type A Quantities. Besides the applicable requirements of paragraph 4-9, the following packages are authorized for shipments that do not exceed Type A quantities.

(1) Each shipper of a specification 7A package must keep on file, for at least 1 year after the latest shipment, and shall provide to DOT, on request, a complete documentation of tests and an engineering evaluation, or comparative data showing that the construction methods, packaging design, and construction materials comply with that specification. Specification 7A packagings designed per requirements in effect on 30 June 1983 and constructed before 1 July 1985 may be used. Packagings designed or constructed after 30 June 1985 must meet the requirements of specification 7A, Type A general packaging (49 CFR 178.350) applicable at the time of their design or construction.

(2) DOT specification 55 metal-encased shielded packaging constructed before 1 April 1975 is not authorized unless it is requalified under DOT specification 7A. Each packaging designed for liquids must also meet the design requirements for Type A packages regarding liquids (49 CFR 173.412(m) and (n)). Use of this packaging as DOT specification 55 is not authorized after 30 June 1985.

(3) Any Type B(U) or B(M) packaging that is an authorized Type B package (49 CFR 173.416).

(4) Any foreign-made packaging that bears the marking Type A and that was used to import radioactive materials. Such packagings may be used later for domestic and export shipments of radioactive materials. The packagings shall conform to requirements of the country of origin applicable to Type A packagings.

b. Type B Quantities. Besides the applicable requirements of paragraph 4-10, Type B quantities of normal-form radioactive materials must be packaged as follows:

(1) Any Type B, B(U), or B(M) packaging that meets the applicable requirements of the US Nuclear Regulatory Commission (10 CFR 71) regulations and that has been approved by that commission may be shipped according to the requirements for US Nuclear Regulatory Commission approved packages (49 CFR 173.471).

(2) Any Type B(U) or B(M) packaging that meets the applicable requirements of the International Atomic Energy Agency (IAEA) *Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition* (as amended) and for which the foreign competent authority certificate has been revalidated by DOT according to 49 CFR 173.473. Authorized only for export and import shipments.

(3) DOT specification 6M (49 CFR 178.104) metal packaging, only for solid or gaseous radioactive materials, that will not undergo pressure generating decomposition at temperatures up to 121°C (252°F) and that do not generate more than 10 watts of radioactive decay heat.

(4) For contents in other than special form, DOT specification 20 WC protective jacket used with a single, snug-fitting inner DOT specification 2R (49 CFR 178.34), or a DOT specification 55 container constructed before 1 April 1975. Such packagings constructed after 31 March 1975 may not be designated as DOT specification 55. For liquid contents, the inner packaging must also comply with the design requirements for Type A packages pertaining to liquids (49 CFR 173.412(m) and (n)).

c. Large Quantities of Radioactive Materials. Large quantities of radioactive materials in normal form must be packaged according to *a*(3) and (4) above. Also, they may be packaged in any other Type B

packaging that meets the pertinent requirements of the IAEA regulations for large quantities of radioactive materials, and for which the foreign competent authority certificate has been revalidated by DOT.

4-12. Requirements for Packaging of Special-Form Radioactive Materials (49 CFR 173.415 and 173.416)

a. Type A Quantities. Besides the applicable requirements of paragraph 4-9, a Type A quantity of special-form radioactive material must be packaged in packaging that meets the requirements outlined in paragraph 4-11*a*. Further, to be special-form radioactive material, the requirements of paragraph 2-40 must be met.

b. Type B Quantities. Besides the applicable requirements of paragraph 4-10, Type B quantities of special-form radioactive materials must also meet the following packaging requirements:

(1) DOT specification 20WC (49 CFR 178.194), wooden protective jacket, with a single snug-fitting inner Type A packaging that has a metal outer wall and that conforms to 49 CFR 178.350, or an inner DOT specification 55 packaging constructed before 1 April 1975. Such packagings constructed after 31 March 1975 may not be designated as DOT specification 55. Radioactive decay heat may not exceed 100 watts.

(2) DOT specification 21WC (49 CFR 178.195), wooden protective overpack, with a single inner DOT specification 2R (49 CFR 178.34) or an inner DOT specification 55 container constructed before 1 April 1975. Such packagings constructed after 31 March 1975 may not be designated as DOT specification 55. Contents shall be loaded within the inner packaging in a manner to prevent loose movement during transport. The inner packaging shall be securely positioned and centered within the overpack so that there will be no significant displacement of the inner packaging if subjected to the 9-meter (30-foot) drop test described in 10 CFR 71.

c. Large Quantities of Radioactive Materials. Large quantities of radioactive materials in special form must be packaged as follows:

(1) According to the requirements outlined in paragraph 4-12*b* of this manual, or

(2) In specification 6M metal packaging (49 CFR 178.104).

(3) In any other Type B packaging that meets the pertinent requirements of the US Nuclear Regulatory Commission (10 CFR 71) regulations and is approved by the Nuclear Regulatory Commission.

(4) In any other Type B packaging that meets the pertinent requirements of the 1973 regulations of the International Atomic Energy Agency and for which the foreign competent authority certificate has been revalidated by DOT.

4-13. General Requirements for Packaging of Fissile Radioactive Materials (49 CFR 173.453)

The packaging of all fissile radioactive materials must comply with the following requirements, except for the radioactive materials that meet the exemption qualifications outlined in *a* below.

a. Fissile Materials Packagings Exemptions.

(1) A package containing not more than 15 grams of fissile radionuclides. If the material is transported in bulk, the quantity limitations apply to the conveyance.

(2) A package containing irradiated natural or depleted uranium, including the products of irradiation if the irradiation has taken place only in the thermal reactor.

(3) A package containing homogeneous solutions or mixtures where:

(*a*) The minimum ratio of hydrogen atoms to fissile radionuclide atoms (H/X) is 5,200.

(*b*) The maximum concentration of fissile radionuclides is 5 grams per liter.

(*c*) The maximum mass of fissile radionuclides in the package is 500 grams, except for a mixture where the total mass of plutonium and uranium-233 does not exceed 1% of the mass of uranium-235, then the limit is 800 grams. If the material is transported in bulk, the quantity limitations apply to the conveyance.

(4) A package containing uranium enriched with a maximum mass of 1% of uranium-235 if the fissile radionuclides are distributed homogeneously throughout the package contents, and if they do not form a lattice arrangement within the package.

(5) A package containing any fissile material if it does not contain more than 5 grams of fissile radionuclides in any 10-liter volume, and if the material is packaged so as to maintain this limit of fissile radionuclide concentration during normal transport.

(6) A package containing not more than 1 kilogram of plutonium, of which not more than 20% by mass may consist of plutonium-239, plutonium-241, or any combination of these radionuclides.

(7) A package containing liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by weight, with total plutonium and uranium-233 of not more than 0.1% of the mass of uranium-235.

(8) A package containing thorium or uranium with not more than 0.72% by weight of fissile material used for shipment solely within the United States.

b. Classification of Fissile Materials Packages (49 CFR 173.455). Except as outlined in *a* above, each package of fissile materials shall be classified as follows:

(1) *Fissile Class I.* These packages may be transported in unlimited number and in any arrangement, and they require no nuclear criticality safety controls during transport. No transport index is assigned to Fissile Class I packages for nuclear criticality safety control; however, the external radiation levels may require a transport index.

(2) *Fissile Class II.* These packages may be transported together in any arrangement but in numbers that do not exceed a total transport index of 50. For nuclear criticality safety control, individual packages may have a transport index of not less than 0.1 and not more than 10. However, the external radiation levels may require a higher transport index. These shipments require no nuclear criticality safety control by the shipper during transport.

(3) *Fissile Class III.* These packages do not meet the requirements of Fissile Class I or II and are controlled by the specific requirements for transporting Fissile Class III shipments (49 CFR 173.457) by appropriate arrangements between the shipper and the carrier.

NOTE

The numerical values for package assignments as Fissile Class I, the transport indexes for Fissile Class II packages, and the conveyance and vehicle limitations for Fissile Class III shipments shall be determined according to 10 CFR 71.

c. Type A Quantities of Fissile Materials (49 CFR 173.417(a)). Except as provided in *a* above, fissile materials containing not more than Type A quantities shall be packaged in one of the following packagings:

(1) DOT specification 6L (49 CFR 178.103), metal packaging, for materials prescribed in *d*(2) below.

(2) DOT specification 6M (49 CFR 178.104), metal packaging, for materials prescribed in *d*(2) below.

(3) Any authorized Type A packages (49 CFR 173.415), limited to the following radioactive materials:

(*a*) 500 grams of uranium-235 in a single shipment as Fissile Class III, or not more than 40 grams of uranium-235 per package as Fissile Class II. For Fissile Class II shipments, the transport index assigned to each package shall not be less than 0.4 for each gram of uranium-235 above 15 grams and up to a maximum of 40 grams (transport index of 10).

(*b*) 320 grams of plutonium-239 as plutonium-beryllium neutron sources in special form. Total radioactivity content may not exceed 20 curies. The transport index to be assigned to each package must be 0.5 for each 20 grams, or a fraction thereof, of fissile plutonium.

(4) Any other Type A or Type B, B(U), or B(M) packaging for fissile radioactive materials that also meets the applicable standards of the US Nuclear Regulatory Commission regulations (10 CFR 71) and that is used per the requirements for US Nuclear Regulatory Commission approved packages (49 CFR 713.471).

(5) Any other Type A or Type B, B(U), or B(M) packaging that also meets the applicable requirements for fissile material packaging in section VI of the International Atomic Energy Agency *Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6,* and for which the foreign competent authority certificate has been revalidated by the Director, OHMT, per the requirements for foreign-made packages (49 CFR 173.473). Authorized only for export and import shipments.

(6) A DOT specification 6J (49 CFR 178.100) or 17H (49 CFR 178.118), 55-gallon steel drum, subject to the following conditions:

(*a*) The quantity may not exceed 350 grams of uranium-235 in any nonpyrophoric form, enriched to any degree in the uranium-235 isotope.

(*b*) Each drum must have at least an 18-gauge body and bottom head and a 16-gauge removable top head with one or more corrugations in the cover near the periphery.

(*c*) The outer drum closure must be at least a 12-gauge bolted ring, with drop-forged lugs, one of which is threaded, and have at least a 1.6-centimeter (5/8-inch)-diameter steel bolt and a lock nut, or equivalent device.

(*d*) At least four equally spaced 12-millimeter (0.5-inch)-diameter vent holes shall be provided on the sides of the drum near the top, each covered with weatherproof tape, or equivalent device.

(*e*) Appropriate main inner container and sufficient packaging material, such as plastic or metal jars or cans, shall be provided such that specification 7A (49 CFR 178.350) provisions are satisfied by the inner packaging.

(*f*) Each inner container shall be capable of venting if subjected to the thermal test described in 10 CFR 71.

(*g*) Liquid contents shall be packaged according to the design requirements for Type A packages pertaining to liquids (49 CFR 173.412 (*m*) and (*n*)).

Table 4-2. Fissile Material Content and Transport Index for Specification 6J or 17H Packages

Maximum U-235 per package (grams)	Minimum transport index per package as Fissile Class II	Maximum packages per transport vehicle as Fissile Class III
350	1.8	72
300	1.0	129
250	0.5	256
200	0.3	500
150	0.1	500
100	0.1	500
50	(*)	(*)

* Fissile Class I.

(*h*) The maximum weight of contents, including internal packaging, may not exceed 90 kilograms (200 pounds), with the fissile material content limited as shown in table 4-2.

(7) Any metal cylinder that meets the performance requirements of Type A quantity (49 CFR 173.415) and Type A general packaging, specification 7A (49 CFR 173.350), may be used as a Fissile Class I package for transporting residual "heels" of enriched solid-uranium hexafluoride without a protective overpack, per table 4-3.

(8) DOT specifications 20PF-1, 20PF-2, or 20PF-3 (49 CFR 178.120) or specification 21PF-1 or 21PF-2 (49 CFR 178.121) phenolic-foam insulated overpack with snug-fitting inner metal cylinders, may be used for materials prescribed in *d*(5) below.

d. Type B Quantities of Fissile Material (49 CFR 173.417(b). Except as provided in *a* above, fissile materials containing more than Type A quantities shall be identified as Type B quantities and shall be packaged in one of the following packagings:

(1) DOT specification 6M (49 CFR 178.103), metal packaging authorized only for uranium-235, plutonium-239, or plutonium-241, as metal, oxide, or compounds that do not decompose at temperatures up to 149°C (300°F). Radioactive decay heat output may not exceed 5 watts. Radioactive materials in normal form shall be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT specification 2R container (49 CFR 178.34). Packages are authorized as Fissile Classes II and III with materials limited per table 4-4.

(2) DOT specification 6M (49 CFR 178.104), metal packaging authorized only for solid radioactive materials that will not decompose at temperatures up to 121°C (250°F). Radioactive decay heat output may not exceed 10 watts. Radioactive material in other than special form shall be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT specification 2R container (49 CFR 178.34).

(*a*) *Fissile Class I.* Fissile Class I packages

Table 4-3. Allowable Content of Uranium Hexafluoride (UF_6) "Heels" in a Specification 7A Cylinder

Maximum cylinder diameter		Cylinder volume		Maximum uranium-235 enrichment (weight percent)	Maximum "heel" weight per cylinder			
					UF_6		Uranium-235	
Inches	Centimeters	Cubic feet	Liters		kg	lb	kg	lb
5	12.7	0.311	8.8	100.0	0.045	0.1	0.031	0.07
8	20.3	1.359	39	12.5	0.227	0.5	0.019	0.04
12	30.5	2.410	68	5.0	0.454	1.0	0.015	0.03
30	76	25.64	725	5.0	11.3	25.0	0.383	0.84
48	122	108.9 (10 tons)	3084	4.5	22.7	50	0.690	1.52
		142.7 (14 tons)	4041	4.5	22.7	50	0.690	1.52

Table 4-4. Authorized Contents, in Kilograms (kg), and Conditions for Specification 6L

Uranium-235		Plutonium[a]		Fissile Class II transport index	Fissile Class II maximum number of packages per transport vehicle
H/X≤3[b]	3≤H/X≤10	H/X≤10	10≤H/X≤20		
14	3.6[c]	—	—	1.3	80
—	—	2.5	2.4	1.8	50

[a] Plutonium solutions are not authorized.
[b] H/X is the ratio of hydrogen to fissile atoms in the inner containment, with all sources of hydrogen in the containment considered.
[c] Volume not to exceed 3.6 liters.

are limited to the following amounts of fissile radioactive materials: 1.6 kilograms of uranium-235; 0.9 kilogram of plutonium (except that, because of the 10-watt thermal decay heat limitation, the limit for plutonium-238 is 0.02 kilogram); and 0.5 kilogram of uranium-233. The maximum ratio of hydrogen to fissile material must not exceed 3, including all sources of hydrogen within the DOT specification 2R container.

(*b*) *Fissile Classes II and III.* Maximum quantities of fissile materials for Fissile Classes II and III, and other restrictions, are given in table 4-5. The table also shows the minimum transport index to be assigned for a Fissile Class II package and the allowable number of similar packages per conveyance and per transport vehicle for a Fissile Class III shipment. Each Fissile Class III shipment is also subject to specific transport requirements (49 CFR 173.457) outlined in paragraph 4-15 of this manual. Where a maximum ratio of hydrogen to fissile material is specified in table 4-5, only the hydrogen interspersed with the fissile material need be considered. For a uranium-233 shipment, the maximum inside diameter of the inner container must not exceed 12.1 centimeters (4.75 inches). Where necessary, a tight-fitting steel insert shall be used to reduce a larger diameter inner container to the 12-centimeter (4.75-inch) limit. The larger diameter inner container used must conform to specification 2R or equivalent (cast iron or brass is prohibited), with a maximum usable inside diameter of 13.3 centimeters(5.25 inches), a minimum usable inside diameter of 10 centimenters (4 inches), and a minimum height of 15 centimeters (6 inches) (49 CFR 178.104-3(b)).

Table 4-5. Authorized Contents for Specification 6M Packages[a]

Uranium-233[b]			Uranium-235[c d]			Plutonium[e f c]			Fissile Class II transport index	Fissile Class III maximum number of packages per transport vehicle
Metal or alloy	Compounds		Metal or alloy	Compounds		Metal or alloy	Compounds			
[g]H/X=0	H/X=0	H/X≤3	H/X=0	H/X=0	H/X≤3	H/X=0	H/X=0	H/X≤3		
3.6	4.4	2.9	7.2	7.6	5.3	3.1	4.1	3.4	0.1	1,250
4.2[h]	5.2	3.5	8.7	9.6	6.4	3.4	4.5	4.1	0.2	625
5.2[h]	6.8	4.5	11.2	13.9	8.3	4.2	—	4.5	0.5	250
—	—	—	13.5	16.0	10.1	4.5	—	—	1.0	125
—	—	—	—	26.0	16.1	—	—	—	5.0	25
—	—	—	—	32.0	19.5	—	—	—	10.0	12

[a] Quantity of kilograms.
[b] Maximum inside diameter of specification 2R container not to exceed 12 centimeters (4.75 in.) (see para (*b*) (2) (ii) of 49 CFR 173.417).
[c] For a mixture of uranium-235 and plutonium, an equal amount of uranium-235 may be substituted for any portion of plutonium authorized.
[d] Maximum permitted uranium-235 enrichment is 93.5 percent.
[e] Minimum percentage of plutonium-240 is 5 percent by weight.
[f] 4.5-kilogram limitation of plutonium due to 10-watt decay heat limitation.
[g] H/X is the ratio of hydrogen to fissile atoms in the inner container.
[h] Granulated or powdered metal with any particle less than 8 millimeters (0.25 in.) in the smallest dimension is not authorized.

Table 4-6. Authorized Quantities of Uranium Hexafluoride (UF_6) as Fissile Class II

Protective overpack specification number	Maximum inner cylinder diameter		Maximum weight of UF_6 contents		Maximum U-235 enrichment (weight percent)	Fissile Class II transport index
	Centimeters	Inches	Kilograms	Pounds		
20PF-1	12.7	5	25	55	100.0	0.1
20PF-2	20.3	8	116	255	12.5	4.0
20PF-3	30.5	12	209	460	5.0	1.1
21-PF-1[a]	76[b]	30[b]	2,247	4,950	5.0	5.0
	76[c]	30[c]	2,279	5,020	5.0	5.0
21-PF-2[a]	76[b]	30[b]	2,247	4,950	5.0	5.0
	76[c]	30[c]	2,279	5,020	5.0	5.0

[a] For 76-centimeter cylinders, the maximum permitted H/U atomic ratio is 0.088.
[b] Model 30A inner cylinder (Reference: ORO-651).
[c] Model 30B inner cylinder (Reference: ORO-651).

(3) Type B, B(U), or B(M) packaging that meets the standards of 10 CFR 71 for packaging fissile materials and that meets the requirements of the US Nuclear Regulatory Commission approved packages (49 CFR 173.471).

(4) Type B(U) or B(M) packaging that meets the applicable requirements for fissile radioactive materials in section VI of the International Atomic Energy Agency (IAEA) *Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6* and for which the foreign competent authority certificate has been revalidated by the Director, Office of Hazardous Materials Transportation (OHMT) in accordance with 49 CFR 173.472. Authorized only for import and export shipments.

(5) DOT specification 20PF-1, 20PF-2, or 20PF-3 (49 CFR 178.120) or specification 21PF-1 or 21PF-2 (49 CFR 178.121) phenolic-foam insulated protective overpacks, with snug-fitting inner metal cylinders meeting the standard requirements for all packages (49 CFR 173.24), general design requirements (49 CFR 173.411), and the additional design requirements for Type A packages (49 CFR 173.412). Handling procedures and packaging criteria shall be according to the US Department of Energy Report No. ORO-651 or NASI Standard N-14.1-1971. Quantities of uranium hexafluoride are authorized as shown in table 4-6, with each package to be shipped as Fissile Class II, and assigned a minimum transport index as also shown.

4-14. Mixing and Combining Packages of Fissile Materials (49 CFR 173.459)

a. Mixing of packages of other types of radioactive materials, including Fissile Class I with Fissile Class II packages, is permitted if the total transport index in any one transport vehicle or storage location does not exceed 50.

b. For Fissile Class II packages shipped under the exclusive-use provisions of 49 CFR 173.441(*b*) to provide for packages with high radiation dose rates, the transport index, which is calculated for nuclear criticality control purposes, must not exceed 10 for any single package or a total of 50 for the full load, unless specifically authorized by DOT for Fissile Class III shipments.

(1) Fissile Class II packages may be shipped with a transport index greater than 10 and combined with other packages of the same or different designs in a Fissile Class III shipment, under the conditions prescribed in paragraph 4-13*b*(3) above, *provided*:

(*a*) The transport index assigned in the package approval for nuclear criticality control purposes does not exceed 10 for any single package;

(*b*) The total transport index for all packages in the shipment does not exceed 100;

(*c*) The shipment satisfies the provisions of 49 CFR 173.441(*b*) if any package has radiation dose rates that exceed 10 millirems per hour at 1 meter from any accessible external surface of the package; and

(*d*) The shipment will not be transported by water.

(2) Fissile Class III packages that have been assigned a transport index for nuclear criticality control purposes, according to Fissile Class II criteria, may be combined with other Fissile Class III packages of the same or different design for which a transport index has been so assigned for nuclear criticality control purposes, and may be combined with Fissile Class II packages, in a Fissile Class III shipment under the condition prescribed in paragraph 4-15 below *provided*:

(*a*) The transport index assigned in the package approval for nuclear criticality control purposes does not exceed 10 for any single package;

(*b*) The total transport index for nuclear criticality control purposes for all packages in the shipment does not exceed 100;

(*c*) The shipment satisfies the provisions of 49 CFR 173.441(*b*) if any package has radiation dose rates that exceed 10 millirems per hour at 1 meter from any accessible external surface of the package; and

(*d*) The shipment will not be transported by water.

4-15. Special Requirements for Fissile Class III Shipments (49 CFR 173.457)

A Fissile Class III shipment may be made only according to *a*, *b*, or *c* below or according to other procedures authorized by DOT. The transport controls must provide nuclear criticality safety and must be carried out by the shipper or carrier, as appropriate, to protect against loading, storing, or transporting that shipment with any other fissile material.

a. Transport in a vehicle assigned for the sole use of that consignor, with a specific restriction for such sole use to be provided in the special arrangements, and with instructions to that effect issued with the shipping papers; or

b. Except for aircraft shipments, transport under the escort of a person in a separate vehicle, with the escort having the capability, equipment, authority, and instruction to provide administrative controls adequate to assure compliance with this paragraph; or

c. Transport in a vehicle containing no other packages of radioactive material that must bear one of the "radioactive" labels described in 49 CFR 172.403. Specific arrangements must be effected between shipper and carrier, with instructions to that effect issued with the shipping papers.

4-16. Fissile Class Assignments and Evaluation of an Array of Packages (49 CFR 173.455 and 10 CFR 71.55 through 71.61)

The numerical values of package assignments as Fissile Class I, the transport indexes for Fissile Class II packages, and the vehicle limitations for Fissile Class III packages must be determined according to paragraphs 4-10 through 4-13 and this paragraph.

a. Specific Assumptions. Specific assumptions concerning the standards set in *b* and *c* below are:

(1) The fissile material is in the most reactive credible configuration, consistent with the damaged condition of the package, the chemical and physical form of the contents and controls exercised over the number of packages to be transported together.

(2) Water moderation occurs to the most reactive credible extent, consistent with the damaged condition of the package and the chemical and physical forms of the contents.

b. Specific Standards for a Fissile Class I Package. A Fissile Class I package shall be so designed and constructed and its contents so limited that:

(1) Any number of such undamaged packages would be subcritical in any arrangement, with optimum interspersed hydrogenous moderation, unless a greater amount of interspersed moderation is in the packaging, in which case that greater amount may be considered; and

(2) A total of 250 such packages would be subcritical in any arrangement if each package were subjected to hypothetical accident conditions, such as free drop, thermal, and water immersion (specified and in the sequence listed in para 4-10), with close reflection by water on all sides of the array and with optimum interspersed hydrogenous moderation unless a greater amount may be considered. The condition of the package shall be assumed to be as described in *a* above.

c. Specific Standards for a Fissile Class III Shipment. A package for Fissile Class III shipment shall be so designed and constructed and its contents, the number of packages, so limited that:

(1) The undamaged shipment would be subcritical with an identical shipment in contact with it and with the two shipments closely reflected on all sides by water; and

(2) The shipment would be subcritical if each package were subjected to hypothetical accident conditions, such as free drop, thermal, and water immersion (specified and in the sequence listed in para 4-10), with close reflection by water on all sides of the array, with the packages in the most reactive arrangement, and with the most reactive degree of interspersed hydrogenous moderation that would be credible considering the controls to be exercised over the shipment. The condition of the package shall be assumed to be as described in *a* above. Hypothetical accident conditions different from those specified in this paragraph may be approved by the US Nuclear Regulatory Commission if the controls proposed to be exercised by the shipper are demonstrated to be adequate to assure safety of the shipment.

4-17. Special Requirements for Plutonium Shipments (49 CFR 71.63, AR 385-11)

a. Plutonium in excess of 20 curies per package shall be shipped as a solid.

b. Plutonium in excess of 20 curies per package

shall be packaged in a separate inner container placed within the outer packaging that meets the requirements of paragraph 4-11 for packaging of material in normal form. The separate inner container shall not release plutonium when the entire package is subjected to the normal and accident test conditions specified in paragraphs 4-9 and 4-10. Solid plutonium in the following forms is exempt from the requirements of this paragraph:

(1) Reactor fuel elements.

(2) Metal or metal alloy.

(3) Other plutonium-bearing solids that the Nuclear Regulatory Commission determines should be exempt from the requirements of this paragraph.

4-18. Petitions for Nonspecification Packaging (AR 385-11, AR 55-355)

Petitions for authorizing nonspecification packaging for fissile radioactive materials must be submitted through command channels to HQDA (DAPE-HRS), WASH DC 20310–0300, with a copy to Cdr, USAMC, ATTN: AMCSF-P, Alexandria, Virginia 22333–0001 and to Cdr, MTMC, ATTN: MT-SS, Washington, DC 20315. The petition must include the following:

a. Type and amount of fissile radioactive materials to be carried in each package, including:

(1) The transport index to be assigned to the package for the proposed package loading when shipped as Fissile Class II; and

(2) The maximum number of packages proposed when shipped as Fissile Class III.

b. A nuclear criticality safety evaluation demonstrating that the package design and contents limitation are adequate to assure nuclear criticality safety. Any tests performed in this respect should be described.

NOTE

When DOT authorization of packages for fissile radioactive materials to be used in shipments by the US Nuclear Regulatory Commission or by one of its contractors or licenses is applied for, a copy of the license amendment or other approval issued by that commission will be accepted in place of the nuclear criticality safety evaluation and the package structural integrity evaluation.

4-19. Special Permits (AR 385-11, AR 55-355)

a. Special permits may be granted by the appropriate regulatory bodies under circumstances where the shipment does not conform to existing regulatory controls, and where it can be demonstrated that equivalent protection to people and to property can be assured in some other manner.

b. The Commander, Military Traffic Management Command (MTMC) will obtain new or modified DOT special permits for the shipment of radioactive materials. However, in emergencies, the military services are authorized to contact the appropriate regulatory body in such matters, provided the Commander, MTMC is promptly informed of each such emergency action. Except in emergencies, requests for special permits will be forwarded through appropriate command channels to the Commander, MTMC. These requests will be submitted in duplicate at least 45 days before the requested effective date and will include the following information, as applicable:

(1) Complete description of commodity, including hazard classification.

(2) Report of tests conducted to determine the hazard classification when the commodity is not covered by the DOT, State, or municipal regulations governing the safe transport of explosives and other dangerous articles.

(3) Origin and destination.

(4) Type of packaging and packing.

(5) Supporting information indicating that proposed shipments are safe for transport.

(6) Justification for special permit, citing specific regulation(s) under which exemption is required.

(7) Estimated total weight of shipment.

(8) Period of time special permit will be required.

(9) Anticipated shipping date(s).

(10) Mode(s) of transportation required.

4-20. Exemption for Limited Quantities of Radioactive Materials (49 CFR 173.421)

Radioactive materials whose activity per package does not exceed the limits specified in table 4-7 are excepted from the specification packaging, shipping paper and certification, marking, and labeling requirements if:

a. The materials are packaged in strong, tight packages that will not leak any of the radioactive materials during normal transport conditions.

b. The radiation level at any point on the external surface of the package does not exceed 0.5 millirem per hour.

c. The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in paragraph 3-11.

d. The outside of the inner packaging or, if there is no inner packaging, the outside of the packaging itself bears the marking "Radioactive."

e. Except for the excepted articles containing natural uranium or thorium (49 CFR 173.424), the pack-

Table 4-7. Activity Limits for Limited Quantities, Instruments, and Articles

Nature of Contents	Instruments and articles		Materials package limits
	Instrument and article limits[a]	Package limits	
Solids:			
Special form	$10^{-2}A_1$	A_1	$10^{-3}A_1$
Other forms	$10^{-2}A_2$	A_2	$10^{-3}A_2$
Liquids:			
Tritiated water:			
< 0.1 Ci/liter			1000 curies
0.1 to 1.0 Ci/liter			100 curies
> 1.0 Ci/liter			1 curie
Other liquids	$10^{-3}A_2$	$10^{-1}A_2$	$10^{-4}A_2$
Gases:			
Tritium[b]	20 curies	200 curies	20 curies
Special form	$10^{-3}A_1$	$10^{-2}A_2$	$10^{-3}A_2$
Other forms	$10^{-3}A_2$	$10^{-2}A_2$	$10^{-3}A_2$

[a] For mixture of radionuclides, see 49 CFR 173.433(b).
[b] These values also apply to tritium in activated luminous paint and tritium absorbed on solid carriers.

age does not contain more than 15 grams of uranium-235.

f. The material is otherwise prepared for shipment to meet the additional requirements for limited quantities of radioactive materials and radioactive instruments and articles (49 CFR 173.421-1).

4-21. Exception for Instruments and Articles (49 CFR 173.422)

Instruments and manufactured articles (including clocks and electronic tubes or apparatus) or similar devices that have, as a component, radioactive materials in gaseous or nondispersible solid form are excepted from the specification packaging, shipping paper and certification, marking, and labeling requirements if:

a. The activity of the instrument or article does not exceed the relevant limit listed in table 4-7.

b. The total activity per package does not exceed the relevant limit listed in table 4-7.

c. The radiation level at 10 centimeters (4 inches) from any point on the external surface of any unpackaged instrument or article does not exceed 10 millirems per hour.

d. The radiation level at any point on the external surface of a package bearing the article or instrument does not exceed 0.5 millirem per hour.

e. The nonfixed (removable) radioactive surface contamination of the external surface of the package does not exceed the limits specified in paragraph 3-11.

f. Except for the excepted articles containing natural uranium or thorium (49 CFR 173.424), the package does not contain more than 15 grams of uranium-235.

g. The instrument or article is otherwise prepared for shipment to meet the additional requirements for limited quantities of radioactive materials and radioactive instruments and articles (49 CFR 173.421-1).

4-22. Exemption for Shipment Quantities of Low Specific Activity Materials (49 CFR 173.423)

Radioactive materials whose activity per package does not exceed the limits specified in paragraph 4-21 and table 4-7 and also meet the requirements of *b* through *d* below are qualified for shipments under the provisions of *a* below.

a. Low specific activity (LSA) radioactive materials consigned as exclusive use are exempt from the provisions of paragraphs 4-4*a*, *b*, *e* and *g*. However, they must be packaged according to the requirements of paragraph 4-11 and must be marked and labeled as required in chapter 5 (49 CFR 172.300 and 172.400).

b. LSA radioactive materials that are moved in an exclusive-use transport vehicle (except aircraft) are exempt from specification packaging, marking, and labeling, provided the shipment meets the requirements of *c* or *d* below.

c. Packaged shipments of LSA materials moved in transport vehicles (except aircraft) assigned for the sole use of that consignor must comply with the following:

(1) Materials must be packaged in strong, tight packages so that there will be no leakage of radioactive material under normal transport conditions.

(2) Packages must not have significant removable surface contamination, according to paragraph 3-11.

(3) External radiation levels must comply with the limits outlined in paragraph 3-13 of this manual (49 CFR 173.411).

(4) Shipments must be loaded by the consignor and unloaded by the consignee from the transport vehicle in which originally loaded.

(5) There must be no loose radioactive material in the car or vehicle.

(6) Shipment must be braced so as to prevent leakage or shift of cargo under normal transport conditions.

(7) Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded according to chapter 5 (49 CFR 172.500), as appropriate.

(8) The outside of each outside package must be stenciled or otherwise marked "Radioactive - LSA."

(9) Specific instructions for maintenance of exclusive-use (sole-use) shipment controls must be provided by the shipper to the carrier. Such instructions must be included with the shipping papers.

d. Unpackaged (bulk) LSA materials shipped in closed transport vehicles (except aircraft) assigned for the sole use of that consignor must comply with the following:

(1) Authorized materials are limited to those outlined in paragraph 3-4*d*.

(2) Bulk liquids must be transported in the following:

(*a*) Specification 103CW, 111A60W7 (49 CFR 179.200 through 179.202) tank cars. Bottom openings in tanks are prohibited.

(*b*) Specification MC310, MC311, MC312, or MC331 (49 CFR 178.337 or 178.343) cargo tanks. These tanks are authorized only where the radioactivity concentration does not exceed 10 percent of the specified LSA levels (49 CFR 173.425c(2)(ii)). The requirements of 49 CFR 173.425c(2)(ii) do not apply to these cargo tanks. Bottom fittings and valves are not authorized. Trailer-on-flatcar service is not authorized.

(3) External radiation levels must comply with 49 CFR 173.393(j)(2) through (4).

(4) Shipments must be loaded by the consignor and unloaded by the consignee from the transport vehicles in which originally loaded.

(5) Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded according to 49 CFR 172.500, as appropriate.

(6) There must be no leakage of radioactive materials from the vehicle.

(7) Specific instructions for maintenance of exclusive-use (sole-use) shipment control must be provided by the shipper to the carrier. Such instructions must be included with the shipping papers.

4-23. Exemption for US Government Material (49 CFR 173.7)

a. Shipment of hazardous materials offered by or consigned to the Department of Defense (DOD) must be packaged, including weight limitations, according to the regulations in 49 CFR 173 and this manual or in containers of equal or greater strength and efficiency as required by DOD regulations. Hazardous materials sold by DOD in packagings that are not marked as prescribed by 49 CFR 173 and this manual may be shipped from DOD installations if DOD certifies, in writing, that the packagings are equal to or greater in strength and efficiency than the packaging prescribed in 49 CFR 713. The shipper shall obtain such certification in duplicate for each shipment. He shall give one copy to the originating carrier and retain the other for no less than 1 year.

b. Shipments of radioactive materials, made by or under the direction or supervision of the US Department of Energy or the Department of Defense, and that are escorted by personnel specifically designated by or under the authority of those agencies, for national security, are not subject to the regulations in 49 CFR 100 through 189.

4-24. Quantity Limitations and Metric Conversion (49 CFR 173.26)

a. When quantity limitations in 49 CFR 171 through 179 are specified only by United States liquid measure for 110 gallons or less, or only by avoirdupois weight for 1,000 pounds or less, quantities measured in metric units may be substituted on an equal basis and up to and including 1 liter per quart and 500 grams per pound.

b. When quantity limitations do not appear in the packaging requirements of this paragraph, the permitted gross weight or capacity authorized for a container to be offered for transport is as shown in the container specification.

Section III. PACKAGING CHECKLISTS

4-25. Use of Checklists

When radioactive materials are prepared for transport, the following checklists can be used as an aid to assure that the packaging is adequate for transport of the materials. Each checklist is designed as a guide to lead the user through a series of questions, the answers to which will lead to the next pertinent question or action necessary to assure that the packaging is adequate. This paragraph acts as an index to ensure that applicable checklists are considered. Answers to all questions below indicate the applicable checklists to use within this section. (Note that each question, except for *a*, is independent, and more than one checklist may be applicable.)

Questions	Applicable paragraph if answer is	
	Yes	No
a. Is the material exempt from specification packaging requirements? (4-26)	4-27 only	4-30
b. Is the material a fissile radioactive material? (4-13*a*, 2-17)	4-35	NA
c. Is the radioactive material in special form? (2-42, 4-8)	4-31	4-32
d. Is there more than a Type A quantity radioactive material? (2-38, 2-46)	4-33 & 4-34	4-33
e. Are special permits required?	4-36	NA

4-26. Exemption Checklist

Answer each question, starting with *a*, and proceed as indicated:

Questions	Applicable paragraph if answer is	
	Yes	No
a. Is the material an exempt normal-form material? (4-20)	4-27	4-26*b*
b. Is the material an exempt manufactured article? (4-21)	4-27	4-26*c*
c. Is the material low specific activity material? (2-22)	4-28	4-26*d*
d. Does material meet the criteria of exempt US Government material? (4-23)	4-27	4-25*a*

4-27. Exempt Materials

Reference to this paragraph indicates that the material is exempt from specification packaging requirements of 49 CFR 173. Other than assuring that packages meet the standard requirements for all packages (para 4-3), no other actions relative to packaging are required.

4-28. LSA Materials Checklist

Answer each question, starting with *a*, and proceed as indicated:

Questions	Applicable paragraph if answer is	
	Yes	No
a. Is the LSA material consigned for exclusive use? (4-22*a*)	4-28*b*	4-29
b. Is the shipment to be transported by aircraft? (4-22*b*)	4-30	4-22*c*
c. Does the shipment meet the exemption criteria for packaged LSA materials? (4-22*c*)	4-27	4-28*d*
d. Does the shipment meet the exemption criteria for unpackaged (bulk) LSA materials? (4-22*d*)	4-27	4-25*a*

4-29. LSA Materials Not Meeting Exclusive-Use Exemption Checklist

The following questions require a yes answer to assure that packaging requirements have been met for LSA materials not meeting exemption criteria. Necessary actions must be taken to ensure that a yes answer can be given to each question before shipment.

a. If applicable, does the material meet the requirements for shipping pyrophoric materials? (4-4*f*)

b. Is the package free of radioactive surface contamination? (4-4*h*)

c. Are radiation dose rate requirements met? (4-4*i, j*)

d. If applicable, are export requirements met? (4-4*k*)

e. Was required package examination performed before first and subsequent shipments? (4-4*l, m*)

f. Is package temperature equilibrium requirement met? (4-4*n*)

g. Does the packaging meet the requirements for packaging normal-form radioactive materials? (See checklist para 4-32.)

4-30. General Packaging Requirements Checklist

The following questions require a yes answer to assure that the general packaging requirements are met. Necessary actions must be taken to assure that a yes answer can be given to each question before shipment.

a. Does the package have the proper seal? (4-4*b*)

b. Is the smallest outside dimension 4 inches or greater? (4-4*c*)

c. Is the package shielding and leak tightness adequate? (4-4*d*)

d. Is the package heat dissipation adequate? (4-4*e*)

e. If applicable, does the material meet the requirements for shipping pyrophoric materials? (4-4*f*)

f. Is the package free of radioactive surface contamination? (4-4*h*)

g. Are radiation dose rate requirements met? (4-4*i, j*)

h. If applicable, are export requirements met? (4-4*k*)

i. Was required package examination performed before first and subsequent shipments? (4-4*l, m*)

j. If a liquid radioactive material, are the leak-resistance and corrosion-resistance requirements met? (4-4*g*)

k. Is the package temperature equilibrium requirement met? (4-*n*)

l. Is there an adequate package quality assurance program? (4-5)

m. Are the applicable specification container requirements met? (4-6)

n. Were adequate materials used in package construction? (4-7)

4-31. Special-Form Radioactive Materials Checklist

The following questions require a yes answer to assure that the special requirements for packaging of radioactive materials in special form are met. Necessary actions must be taken to assure that a yes answer can be given to each question before shipment of radioactive materials in special form.

a. Is the required certification and safety analysis available? (4-8)

b. If required, has the Certificate of Competent Authority been obtained? (4-8)

c. For Type A quantities, are questions (1) and (2) below answered yes?

(1) Are the applicable requirements for Type A packaging met? (See checklist 4-33.)

(2) Are the applicable specification containers being used? (4-12*a*)

d. For Type B quantities, are questions (1) and (2) below answered yes?

(1) Are the applicable requirements for Type B packaging met? (See checklist 4-34.)

(2) Are the applicable specification containers being used? (4-12*b*)

e. For large quantities, are the applicable specification containers being used? (4-12*c*)

4-32. Normal-Form Radioactive Materials Checklist

The following questions require a yes answer to assure that the special requirements for packaging of radioactive materials in normal form are met. Necessary actions must be taken to assure that a yes answer can be given to each question before shipment of radioactive materials in normal form.

a. Are the applicable requirements for Type B packaging met? (See checklist 4-34.)

b. Are the applicable specification containers being used? (4-11*b*)

c. For large quantities, are the applicable specification containers being used? (4-11*c*)

4-33. Type A Packaging Checklist

The following questions require a yes answer to assure that packages for Type A quantities of radioactive materials are adequate to contain the materials. Necessary action must be taken to assure that a yes answer can be given to each question before use of the package for radioactive materials shipment.

a. Are there documents to indicate that either an engineering evaluation or applicable tests were conducted? (para 4-9)

b. Do the documents show that, when subjected to the test conditions and environments specified:

(1) The package would not release radioactive material. (4-9)

(2) The effectiveness of the package would not be substantially reduced? (4-9)

(3) There would be no mixture of gases or vapors in the package, which could, through any credible increase of pressure or explosion, significantly reduce the effectiveness of the package? (4-9)

4-34. Type B Packaging Checklist

The following questions require a yes answer to assure that packages for Type B quantities of radioactive materials are adequate to contain the materials. Necessary actions must be taken to assure that a yes answer can be given to each question before use of the packages for radioactive materials shipment.

a. Does the packaging meet the requirements for Type A packaging? (See checklist 4-33.)

b. Are there documents to indicate that either an engineering evaluation or applicable tests were conducted? (4-10)

c. Do the documents indicate that, when subjected to the hypothetical accident conditions, the package would meet the requirements? (4-10)

4-35. Fissile Materials Checklist

The following questions require a yes answer to assure that packages for fissile radioactive materials are adequate. Special checks are included to ensure that the quantities in any shipment do not exceed safety limits. Necessary actions must be taken to assure that a yes answer can be given to each question before use or acceptance of the package(s) for transport.

a. For Type A quantities, are proper specification containers being used? (4-13*c*)

b. For Type B quantities, are proper specification containers being used? (4-13*d*)

c. For shipments that include both Fissile Classes I and II packages, is the total transport index below 50? (4-14*a*)

d. For exclusive use shipments of Fissile Class II, are transport index requirements met? (4-14*b*)

e. For Fissile Class III shipments, are special requirements satisfied? (4-15)

f. Are fissile class assignments proper? (4-16)

g. For plutonium shipments, are all special requirements met? (4-17)

h. If required, have necessary petitions and approvals of nonspecification packaging been obtained? (4-18)

4-36. Special Permits

If required, special permits may be granted by appropriate regulatory bodies. Paragraph 4-19 outlines procedures for requesting the necessary permits.

CHAPTER 5
MARKING, LABELING, PLACARDING, AND DOCUMENTATION

Section I. GENERAL

5-1. Purpose of Marking, Labeling, Placarding, and Documentation

a. The purpose of marking, labeling, and placarding is to ensure that the risks associated with a radioactive shipment are identified to all personnel who may come in contact with the shipment.

b. The purpose of documentation is to ensure that all shipments of radioactive materials are properly controlled, recorded, and accounted for before, during, and after shipment. The documentation provides for adequate information transfer in case of accident, incident, or damage to a shipment. It also provides assurance that the identity of all personnel or items that may be jeopardized by radioactive contamination is available.

5-2. Organization and Use

Section II of this chapter provides the rules and regulatory guidance as indicated in pertinent NRC, DOT, FAA, Coast Guard, postal service, and military regulations. Section III provides detailed guidance on forms, documents, and checklists for use in compliance with the regulations.

Section II. REGULATORY REQUIREMENTS AND PROCEDURES

5-3. General Marking Requirements (49 CFR 172.300)

Unless otherwise exempt, each package containing radioactive material must be marked as follows:

a. Proper shipping name, as shown in 49 CFR 172.101, to include name of radionuclides, if known (that is, fissile radioactive materials and devices; low specific activity, small quantity, and not otherwise specified (nos) radioactive materials; special form; thorium nitrate, solid; and uranyl nitrate, solid).

b. DOT specification container number (49 CFR 178), if specification container is prescribed.

c. Name and address of consignee, except in carloads and truckloads or in less than truckloads, when handled by a motor vehicle not requiring transfer from one motor carrier to another.

d. Name and address of consignee, or shipping mark and number, when offered for transport by vessel, except for carloads and truckloads, provided the vessel delivers the shipment complete to a connecting carrier or a single consignee.

e. Outside containers of hazardous liquids must be marked "THIS SIDE UP" or "THIS END UP" on the cover or top to indicate the position of the inside container. Also, an arrow symbol indicating this way up should be used. Arrows on packages containing hazardous material liquids must not be used for any purpose other than package orientation instruction.

f. Each package of radioactive materials in excess of 110 pounds (50 kilograms) must have its gross weight plainly and durably marked on the outside of the package.

g. Packages that conform to the requirements of Type A or B packaging (chap 4 of this manual, or 49 CFR 173.411 through 173.413) must be plainly and durably marked on the outside of the package in letters at least 1/2-inch (13-mm) high, with the words "TYPE A" or "TYPE B" as appropriate. Packaging that is not in compliance with these requirements may not be so marked.

h. Each package of radioactive material to be exported also must be marked with "USA" in conjunction with specification marking or other package certificate identification.

i. For export shipments, packages on which the proper shipping name includes the nos designation must also include the technical name of the material after the shipping name.

j. The required markings must:

(1) Be durable, in English, and printed on or affixed to the surface of the package on a label, tag, or sign.

(2) Contain no abbreviations.

(3) Be displayed on a background of sharply contrasting color.

(4) Be unobscured by labels or attachments.

(5) Be located away from any other marking (such as advertising) that could substantially reduce its effectiveness.

k. Additional shipping information inconsistent with regulations may be shown on a container, provided that no such label or marking shall be of such a design, form, or size that it may be confused with prescribed labels or markings.

5-4. Marking Requirements for Items Shipped by the US Postal Service

For the marking requirements for packages of radioactive materials shipped by the USPS, see chapter 14.

5-5. General Labeling Rules (49 CFR 172.400 through 172.450)

a. Shippers must furnish and attach labels. Labels should be applied to that part of the package bearing consignee's name and address.

b. Labels *must not* be applied to packages that are not subject to federal regulations or are specifically exempt.

c. Labels must conform to DOT standards as to size, printing, and color. Shippers must not use labels that, by their size, shape, and color, may be confused with standard DOT labels.

d. An EMPTY label (SF 417) (49 CFR 172.450) must be applied to empty containers on which the old label has not been removed, obliterated, or destroyed. See paragraph 3-12 for additional requirements.

5-6. Application of Labels for Radioactive Materials (AR 700-64, 49 CFR 172.400 through 172.450, and 49 CFR 173.44)

a. Army packages containing radioactive material must be marked and labeled according to MIL-STD-129J. Each package of radioactive materia (unless excepted from labeling according to 49 CF 173.421 through 174.425) must be labeled as pro vided in this chapter.

b. The proper label to affix to a package of radioac tive material is based on the radiation level at th surface of the package, the transport index (par 2-46), and if appropriate, the fissile characteristic of the package. The proper category of label shall b determined according to table 5-1. The label to b applied shall be the highest category required fo any of the three determining conditions for th package. Radioactive White-I is the lowest categor and Radioactive Yellow-III is the highest. For ex ample, a package with a transport index of 0.8, a maximum surface radiation level of 60 millirems per hour, and no fissile material must bear a Radioac tive Yellow-III label.

c. Each package containing a radioactive material that also meets the definition of one or more additional hazards must be labeled as a radioactive material and for each additional hazard.

d. Each package required to be labeled with a "Radioactive" label must have two of these labels, affixed to opposite sides of the package (excluding the bottom). (See 49 CFR 172.406(e)(3) for freight container label requirements.)

e. The following applicable items of information must be printed legibly in the blank spaces on the "Radioactive" label using a durable, weather-resistant means of marking:

(1) *Contents.* The name of the radionuclides as taken from the listing of radionuclides in table 2-2. For mixtures of radionuclides, the most restrictive radionuclide on the basis of radiotoxicity must be listed as label space allows.

(2) *Activity.* Units shall be expressed in appropriate curies (Ci), millicuries (mCi), or microcuries (uCi). Abbreviations are authorized. For a fissile material, the weight, in grams or kilograms, of the fissile radioisotope also may be inserted.

(3) *Transport Index.* See paragraph 2-46 for description.

Table 5-1. Label Categories for Radioactive Materials Packages

Transport index (T.I.)	Radiation level at package surface (RL)	Fissile criteria	Label category*
N/A	RL ≤ 0.5 millirem per hour (mrem/h)	Fissile Class I only, no Fissile Class II or III	White-I
T.I. ≤ 1.0	0.5 mrem/h < RL ≤ 50 mrem/h	Fissile Class I, Fissle Class II, with T.I. ≤ 1.0 no Fissile Class III	Yellow-II
1.0 < T.I.	50 mrem/h RL	Fissile Class II with 1.0 < T.I., Fissile Class III	Yellow-III

*Any package containing a "highway route controlled quantity" (49 CFR 173.403) must be labeled Radioactive Yellow-III.

f. The radioactive class labels are as follows:
(1) *Radioactive White-I.*

RADIOACTIVE WHITE - I

LABEL MUST BE DIAMOND SHAPED WITH AT LEAST 4 INCHES (101 MM) ON EACH SIDE AND WITH A BLACK SOLID LINE BORDER ON EACH SIDE 1/4 INCH (6.3 MM) FROM THE EDGE. THE LABEL MUST BE WHITE; THE PRINTING AND SYMBOL MUST BE BLACK EXCEPT FOR THE "I," WHICH MUST BE RED. ALSO, IT MUST COMPLY WITH THE LABEL SPECIFICATIONS OF 49 CFR 172.407.

Figure 5-1. Radioactive White-I label (SF 413).

(2) *Radioactive Yellow-II.*

RADIOACTIVE YELLOW - II

LABEL MUST BE DIAMOND SHAPED WITH AT LEAST 4 INCHES (101 MM) ON EACH SIDE AND WITH A BLACK SOLID-LINE BORDER ON EACH SIDE 1/4 INCH (6.3 MM) FROM THE EDGE. THE LABEL MUST BE YELLOW IN THE TOP HALF AND WHITE IN THE LOWER HALF. THE PRINTING AND SYMBOL MUST BE BLACK EXCEPT FOR THE "II," WHICH MUST BE RED. ALSO, IT MUST COMPLY WITH THE LABEL SPECIFICATIONS OF 49 CFR 172.407.

Figure 5-2. Radioactive Yellow-II label (SF 414).

(3) *Radioactive Yellow-III.*

RADIOACTIVE YELLOW - III

LABEL MUST BE DIAMOND SHAPED WITH AT LEAST 4 INCHES (101 MM) ON EACH SIDE AND WITH A BLACK SOLID-LINE BORDER ON EACH SIDE 1/4 INCH (6.3 MM) FROM THE EDGE. THE LABEL MUST BE YELLOW IN THE TOP HALF AND WHITE IN THE LOWER HALF. THE PRINTING AND SYMBOL MUST BE BLACK EXCEPT FOR THE "III," WHICH MUST BE RED. ALSO, IT MUST COMPLY WITH THE LABEL SPECIFICATIONS OF 49 CFR 172.407.

Figure 5-3. Radioactive Yellow-III label (SF 415).

5-7. Application of Mixed Labels (49 CFR 172.403(e))

Radioactive materials with other hazardous characteristics also must be labeled with other labels as required according to the hazards of the commodity.

5-8. Labeling Exemption for Department of Defense Material (49 CFR 172.400)

Packages containing radioactive material are exempt from labeling requirements if loaded and unloaded under the supervision of DOD personnel and escorted by DOD personnel in a separate vehicle.

5-9. Labeling Exemption for Shipment Onboard Vessels

Individual packages of radioactive materials are exempt from labeling requirements provided they are not removed from the railcar, motor vehicle, van, seavan, or portable container while aboard vessels. However, shipping documents must contain the information described in paragraph 5-18, and vehicles, vans, or containers must be properly placarded as provided in paragraph 5-15.

5-10. Special Labeling Requirements for Aircraft Shipments (49 CFR 175.30)

Each package transported aboard an aircraft will be appropriately labeled, although otherwise exempt by reason of DOT quantity and packing limitations.

5-11. Radiation Hazard Symbol Requirements (10 CFR 20.203)

a. Radioactive materials licensed by the NRC, which are packaged and labeled according to the DOT regulations, are exempt from the labeling and posting requirements of 10 CFR 20.203 during shipment.

b. As 10 CFR 20.203(f) requires, containers with more than the quantities of radioactive materials specified in table 5-2 (10 CFR 20, app C) must be labeled with a durable, clearly visible radiation caution symbol (fig 5-4); the words "Caution (or Danger) Radioactive Materials"; and sufficient information,

Table 5-2. Quantities of Materials Requiring Radiation Hazard Symbols

Material	Microcuries	Material	Microcuries
Americium-241	0.01	Copper-64	100
Antimony-122	100	Dysprosium-165	10
Antimony-124	10	Dysprosium-166	100
Antimony-125	10	Erbium-169	100
Arsenic-73	100	Erbium-171	100
Arsenic-74	10	Euorpium-152 9.2h	100
Arsenic-76	10	Europium-152 13 yr	1
Arsenic-77	100	Europium-154	1
Barium-131	10	Europium-155	10
Barium-133	10	Fluorine-18	1,000
Barium-140	10	Gadolinium-153	10
Bismuth-210	1	Gadolinium-159	100
Bromine-82	10	Gallium-72	10
Cadmium-109	10	Germanium-71	100
Cadmium-115m	10	Gold-198	100
Cadmium-115	100	Gold-199	100
Calcium-45	10	Hafnium-181	10
Calcium-47	10	Holmium-166	100
Carbon-14	100	Hydrogen-3	1,000
Cerium-141	100	Indium-113m	100
Cerium-143	100	Indium-114m	10
Cerium-144	1	Indium-115m	100
Cesium-131	1,000	Indium-115	10
Cesium-134m	100	Iodine-125	1
Cesium-134	1	Iodine-126	1
Cesium-135	10	Iodine-129	0.1
Cesium-136	10	Iodine-131	1
Cesium-137	10	Iodine-132	10
Chlorine-36	10	Iodine-133	1
Chlorine-38	10	Iodine-134	10
Chromium-51	1,000	Iodine-135	10
Cobalt-58m	10	Iridium-192	10
Cobalt-58	10	Iridium-194	100
Cobalt-60	1	Iron-55	100

Table 5-2. Continued

Material	Microcuries	Material	Microcuries
Iron-59	10	Strontium-85	10
Krypton-85	100	Strontium-89	1
Krypton-87	10	Strontium-90	0.1
Lanthanum-140	10	Strontium-91	10
Lutetium-177	100	Strontium-92	10
Manganese-52	10	Sulfur-35	100
Manganese-54	10	Tantalum-182	10
Manganese-56	10	Technetium-96	10
Mercury-197m	100	Technetium-97m	100
Mercury-197	100	Technetium-97	100
Mercury-203	10	Technetium-99m	100
Molybdenum-99	100	Technetium-99	10
Neodymium-147	100	Tellurium-125m	10
Neodymium-149	100	Tellurium-127m	10
Nickel-59	100	Tellurium-127	100
Nickel-63	10	Tellurium-129m	10
Nickel-65	100	Tellurium-129	100
Niobium-93m	10	Tellurium-131m	10
Niobium-95	10	Tellurium-132	10
Niobium-97	10	Terbium-160	10
Osmium-185	10	Thallium-200	100
Osmium-191m	100	Thallium-201	100
Osmium-191	100	Thallium-202	100
Osmium-193	100	Thallium-204	10
Palladium-103	100	Thorium (natural)[1]	100
Palladium-109	100	Thulium-170	10
Phosphorus-32	10	Thulium-171	10
Platinum-191	100	Tin-113	10
Platinum-193m	100	Tin-125	10
Platinum-193	100	Tungsten-181	10
Platinum-197m	100	Tungsten-185	10
Platinum-197	100	Tungsten-187	100
Plutonium-239	0.01	Uranium (natural)[2]	100
Polonium-210	0.1	Uranium-233	0.01
Potassium-42	10	Uranium-234, Uranium-235	0.01
Praseodymium-142	100	Vanadium-48	10
Praseodymium-143	100	Xenon-131m	1,000
Promethium-147	10	Xenon-133	100
Promethium-149	10	Xenon-135	100
Radium-226	0.01	Ytterbium-175	100
Rhenium-186	100	Yttrium-90	10
Rhenium-188	100	Yttrium-91	10
Rhodium-103m	100	Yttrium-92	100
Rhodium-105	100	Yttrium-93	100
Rubidium-86	10	Zinc-65	10
Rubidium-87	10	Zinc-69m	100
Ruthenium-97	100	Zinc-69	1,000
Ruthenium-103	10	Zirconium-93	10
Ruthenium-105	10	Zirconium-95	10
Ruthenium-106	1	Zirconium-97	10
Samarium-151	10	Any alpha-emitting	
Samarium-153	100	radionuclide not listed	
Scandium-46	10	above or mixtures of	
Scandium-47	100	alpha emitters of un-	
Scandium-48	10	known composition.	0.01
Selenium-75	10	Any radionuclide other	
Silicon-31	100	than alpha-emitting	
Silver-105	10	radionuclides not listed	
Silver-110m	1	above or mixtures of	
Silver-111	100	beta emitters of unknown	
Sodium-24	10	compositions.	0.1

[1] Based on alpha disintegration rate of Th-232, Th-230, and their daughter products.
[2] Based on alpha disintegration rate of U-238, U-234, and U-235.

RADIATION SYMBOL

10 CFR 20.203 PRESCRIBES USE OF THE RADIATION SYMBOL SHOWN BELOW AS APPROPRIATE ON SIGNS AND CONTAINERS. WHEN USED ON LABELS OR SIGNS IN CONFORMANCE WITH NRC REGULATIONS, THE SYMBOL WILL BE MAGENTA OR PURPLE AND THE BACKGROUND WILL BE YELLOW. THE PROPORTIONS OF THE SYMBOL WILL BE AS SHOWN. THE OVERALL SIZE OF THE SYMBOL WILL BE NOT LESS THAN 1 (ONE) INCH.

Figure 5-4. Radiation symbol.

such as radiation levels, kinds of material, estimated activity, and so forth, to permit individuals handling or using the containers to take precautions to avoid or minimize exposure. Two examples are shown in figures 5-5 and 5-6.

NOTE

For purposes of paragraph 5-11, where a combination of isotopes in known amounts is involved, the limits for the combination should be derived as follows: Determine, for each isotope in combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed 1 (that is unity). Example, if a particular container contains 20 microcuries of Au-198 (gold) and 50 microcuries of C-14 (carbon), it may also contain not more than 3 microcuries of I-134 (iodine) before a radiation symbol is required. This limit is determined as follows:

$$\frac{\text{20 Ci Au-198}}{\text{100 Ci}} + \frac{\text{50 Ci C-14}}{\text{100 Ci}} + \frac{\text{3 Ci I-134}}{\text{10 Ci}} = 1.0$$

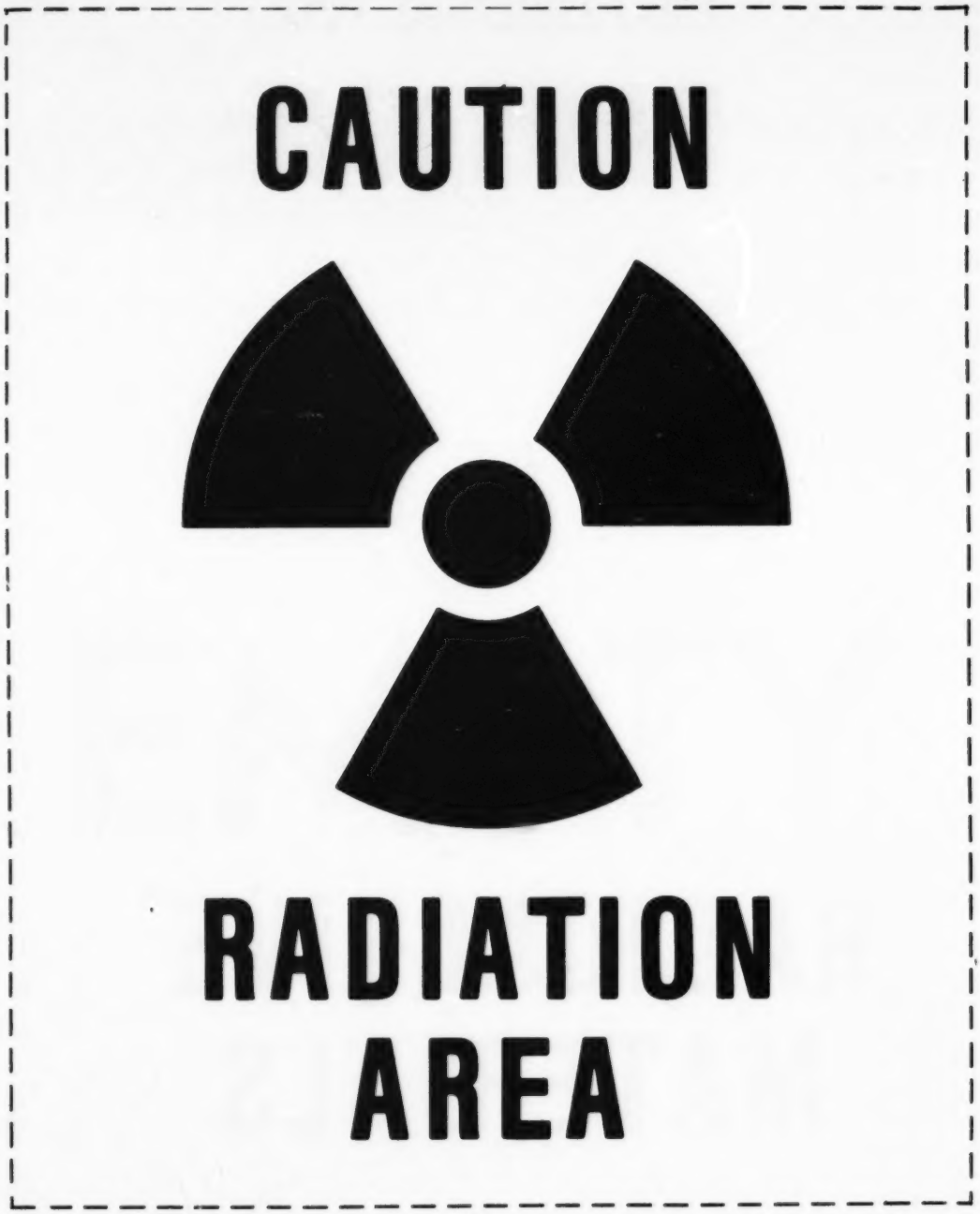


Figure 5-5. Radiation area warning sign.

5-12. Labeling of Empty Containers (49 CFR 173.427)

Any package or accessory that has been used for a shipment of radioactive materials and that contains residual internal radioactive contamination, when shipped as empty, must:

a. Conform to the requirements of paragraph 3-12.

b. Have all hazard labels removed, obliterated, destroyed, or completely covered by an EMPTY label (SF 417) (fig 5-7).

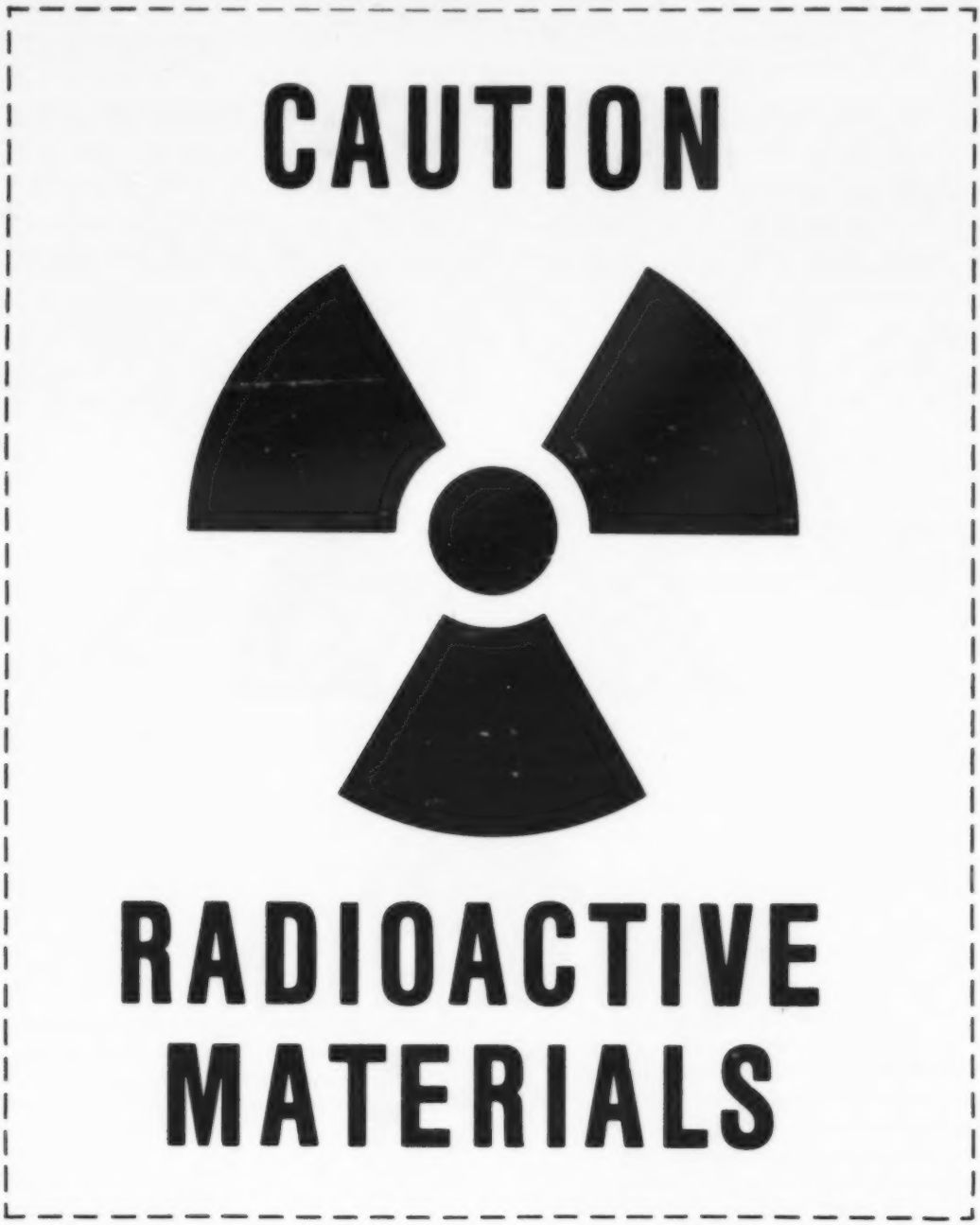


Figure 5-6. Radioactive materials warning sign.

5-13. General Placarding Requirements (49 CFR 172.504)

The appropriate placard or marking, as shown in figure 5-8, must be applied to railcars or motor vehicles transporting radioactive materials as follows:

a. Railcars and vehicles containing packages of radioactive material bearing a "Radioactive Yellow-III" label (49 CFR 172.504 through 172.519).

b. Rail carload shipments of LSA radioactive materials (para 2-22), and carload shipments of radioactive materials shipped under the general packaging and shipping requirements described in chapter 4 of this manual (49 CFR 173.425).

EMPTY CONTAINER LABEL

LABELS FOR EMPTY CONTAINERS MUST BE NOT LESS THAN 6 INCHES ON EACH SIDE, WHITE IN COLOR, AND PRINTED WITH BLACK LETTERS NOT LESS THAN 1-INCH HIGH (49 CFR 172.450).

Figure 5-7. Empty container label (SF 417).

"RADIOACTIVE" PLACARD

THE TOP PORTION OF THE "RADIOACTIVE" PLACARD MUST BE YELLOW AND THE SYMBOL BLACK. THE LOWER PORTION MUST BE WHITE AND THE INSCRIPTION BLACK.

Figure 5-8. Radioactive placard (49 CFR 172.556).

c. Placards must conform to standards prescribed by DOT regulations (49 CFR 172.500 through 172.558).

5-14. Placarding of Mixed Lading

Any motor vehicle with a mixed lading of dangerous articles that require placarding (including radioactive materials with a total gross weight of 1,000 pounds or more) will bear all markings or placards applicable to hazardous materials.

5-15. Application and Supply of Placards (49 CFR 172.500 through 172.558)

a. Shippers must furnish and apply placards for shipments loaded by them. Source of supply for the railcar placard is as indicated in paragraph 33-11, Labels and Placards, AR 55-355. Placard for motor vehicles is available as DA Label 110, which is available through normal AG publications supply channels.

b. Placards must be applied securely on each end and side of railcars, motor vehicles, vans, trailers loaded on flatcars, or portable containers.

5-16. Special Requirements for Transport Vehicles Shipped Aboard Vessels

Railcars, motor vehicles, vans, seavans, or portable containers loaded with radioactive materials and *shipped aboard vessels* will be properly placarded, as prescribed by DOT regulations and will carry an identification number. Also, the prescribed package label will be conspicuously displayed on the outside of the railcar, motor vehicle, van, seavan, or container.

5-17. Placarding Exemptions (49 CFR 172.500 through 172.529, 174, and 177)

The following shipments are exempt from the requirements of paragraphs 5-14 through 5-16 above:

a. Railcars containing packages of radioactive material described in paragraphs 4-20 and 4-21.

b. Railcars containing packages bearing Radioactive White-I and/or Radioactive Yellow-II labels.

c. Sole-use railcars containing packaged shipments of unconcentrated uranium or thorium ores.

d. Military shipments are specifically exempted by DOT in writing.

5-18. General Requirements for Shipping Papers (49 CFR 172.200 through 172.204)

Each shipper of radioactive material will enter the following information on the Government bill of lading, shipping order, or other shipping papers, delivery receipts, or dock receipts:

a. Proper shipping name prescribed for the material as specified by 49 CFR 172.101. (See also para 5-3*a*.) Abbreviations should not be used.

b. The hazard class of the material as specified in 49 CFR 172.101 (for example, Radioactive Materials).

c. Except for empty packagings, indicate the total number of packages and the weight of each one over 110 pounds. Also enter the total number of pieces or packagings.

d. The type of packaging used (for example, bol, cylinder, drum, and so forth).

e. The name of each radionuclide included in the radioactive material (table 2-2). Abbreviations - for example, Mo for molybdenum - are authorized.

f. A description of the physical and chemical form of the material if the material is in normal form.

g. The DOT exemption number, if applicable.

h. The activity contained in each package of the shipment, in terms of curies, millicuries, or microcuries.

i. The type of label applied to each package in the shipment (that is, RADIOACTIVE WHITE-I, and so forth). Where the regulations exempt the packages from labeling, the exemption must be indicated by the words "No Label Required" immediately after the description on the shipping papers.

j. The transport index (para 2-46) assigned to each package in the shipment bearing Radioactive Yellow-II or Radioactive Yellow-III labels.

k. Shipper's certification, if required (para 5-19).

l. For a package approved by the US Department of Energy (DOE) or US Nuclear Regulatory Commission (NRC), a notation of the package identification marking as prescribed in the applicable DOE or NRC approval (49 CFR 173.471(b)).

m. For shipment in a foreign-made package, a notation of the package identification marking as prescribed in the applicable International Atomic Energy Administration (IAEA) Certificate of Competent Authority which has been issued for the package (49 CFR 173.471(d) and 173.473(b)).

n. For empty containers, the bill of lading description should be substantiated as follows: "Empty containers that have contained radioactive materials."

o. Any other special instructions that are necessary to ensure safe transport, handling, storage, or disposal of the shipment.

5-19. Shipper's Certification (49 CFR 173.421 through 173-424)

a. General. Except when the DOT exemption statement is used per 49 CFR 173.421-1 or as provided in *b* and *c* below, each person who offers a hazardous material for transport shall certify that the material

is according to this paragraph by printing (manually or mechanically) the following statement on the shipping paper containing the required shipping description:

> This is to certify that the above-named materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transport according to the applicable regulations of the Department of Transportation.

NOTE

> In line one of the certification, the words "herein-named" may be substituted for the words "aboved-named."

b. Exceptions. No certification is required for hazardous material offered for highway transport that is transported —

(1) In a cargo tank supplied by the carrier, or

(2) By the shipper as a private carrier except for a hazardous material that is to be reshipped or transferred from one carrier to another.

c. Transport by Air.

(1) *General.* Certification containing the following language may be used in place of the certification required by *a* above:

> I hereby certify that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in proper condition for air carriage according to applicable national Government regulations.

(2) *Certificate in Duplicate.* Each person who offers a hazardous material for air transport shall provide, to the aircraft operator, two copies of the certification required in this section (49 CFR 174.30).

(3) *Passenger and Cargo Aircraft.* Each person who offers for air transport a hazardous material authorized for such transport shall add to the certification required in this section the following statement:

> This shipment is within the limitations prescribed for passenger aircraft/cargo-only aircraft (delete nonapplicable).

(4) *Radioactive Material.* Each person who offers any radioactive material for transport aboard a passenger-carrying aircraft shall sign (mechanically or manually) a printed certificate stating that the shipment contains radioactive materials intended for use in, or incident to, research, medical diagnosis, or treatment. This requirement does not apply to materials excepted under the provisions of 49 CFR 175.10(*a*)(8).

d. Signature. The certifications required by *a* or *c* above:

(1) Must be legibly signed by a principal, officer, partner, or employee of the shipper or his agent; and

(2) May be legibly signed manually, by typewriter, or by other mechanical means.

5-20. Shipping Papers for Fissile Materials (49 CFR 172.203)

Besides the requirements in paragraphs 5-18 and 5-19, shipping papers for shipments of fissile materials must contain the following information:

a. The words "Fissile Exempt" if the package is exempt pursuant to paragraph 4-13.

b. If not exempt, the fissile class of each package in the shipment. Fissile classes are as determined in paragraphs 2-17 and 4-16.

c. For Fissile Class III shipments, the notation, "Warning - Fissile Class III Shipment. Do not load more than ** Packages per Vehicle." (Asterisks are to be replaced by appropriate number.) The following notation will also appear, "In Loading and Storage Areas, Keep at Least 20 Feet (6 Meters) From Other Packages Bearing Radioactive Labels."

d. For Fissile Class III shipments to be transported by water, the supplementary notation must also include the following statement: "For shipment by water, only one Fissile Class III shipment is permitted in each hold."

5-21. Shipping Papers for Export Shipments (49 CFR 172.203)

Besides the applicable requirements of paragraphs 5-18 through 5-20, shipping papers for export shipments must contain the package identification marking, as prescribed in the applicable International Atomic Energy Agency (IAEA) Certificate of Competent Authority, which has been issued for the package (49 CFR 173.473(c)).

5-22. Shipping Papers for Air Transport (49 CFR 172.203)

Besides the applicable portions of paragraphs 5-18 through 5-21, the shipping papers for air transport of a package containing a radioactive material prohibited from being transported aboard passenger-carrying aircraft (para 10-5*b*) must contain the words "Cargo Aircraft Only" after the basic description.

5-23. Shipping Papers for Highway or Rail Transport (49 CFR 172.203)

Besides the applicable portions of paragraphs 5-18 through 5-21, shipping papers for a transport vehicle requiring placarding (paras 5-13, 5-14, and 5-17) must contain the notation "Placarded" after the name(s) of the required placard(s).

5-24. Shipping Papers for Water Transport (49 CFR 172.203)

Besides the applicable portions of paragraphs 5-18 through 5-21, shipping papers for each water shipment must have the following:

a. Identification of the type of packages, such as barrels, drums, cylinders, and boxes.

b. The number of each type of package, including those in a freight container or on a pallet.

c. The gross weight of each type of package, or the gross weight of each individual package.

d. NRC (AEC) export license number (if applicable).

e. Net weight of radioactive material.

f. Level of radiation dose rate at the surface of each package.

g. Level of radiation dose rate at 1 meter from each package.

h. Common commodity name of the end-item that contains radioactive material; for example, electron tubes, compass, electronic instrument, and so forth.

i. Indication of "IMCO Class 7."

j. For water shipments to any country outside the United States, the technical name of the material must be included in parentheses after the proper shipping name when the material is described by a "nos" entry in 49 CFR 172.101, for example, Radioactive Material, Fissile, nos (Uranium-235), Radioactive Material. For a mixture, only the technical name of any hazardous material that gives the mixture its hazardous properties must be identified.

5-25. Reports of Shipment (REPSHIP) and Arrival (AR 385-11)

a. REPSHIP. The shipping installation transportation officer will send to the receiving installation, by electrical means, a REPSHIP on all nonexempt shipments of radioactive materials. This REPSHIP will contain the following information, as applicable, retaining the sequence of paragraphs as follows:

(1) Transportation release number.

(2) Shipping order number.

(3) Carrier and routing.

(4) Car or other vehicle number.

(5) Bill of lading number(s).

(6) Requisition number and reference to message authorizing shipment.

(7) Brief description of contents, including radiation levels and dimensions and weights of items requiring special handling equipment.

(8) Date and time of departure.

(9) Expected time of arrival.

(10) Name, rank, grade, and social security number of technical escorts, if any.

b. Arrival. The receiving installation transportation officer will submit to the shipping installation, by electrical means, a report of arrival on all nonexempt shipments of radioactive materials. This report will identify the shipments by reference to the REPSHIP and will furnish time and date of arrival and physical condition of package(s) on arrival. If a shipment has not arrived at its destination within 24 hours after the estimated time of arrival (ETA), the consignee will so notify the consignor by electrical means, and the consignor will take immediate steps to trace the shipment.

5-26. Marking, Labeling, Placarding, and Documentation for Shipment by Military Aircraft (ARF 71-4/TM 38-250)

a. Basic requirements for handling and shipping of radioactive materials by military (USAF cargo) aircraft are contained in chapter 12 of AFR 71-4/TM 38-250.

b. Special marking requirements for hazardous materials shipped by military aircraft are detailed in AFR 71-4/TM 38-250.

c. Special labeling requirements for hazardous materials shipped by military aircraft are detailed in AFR 71-4/TM 38-250, paragraph 13-2.

d. DD Form 1387-2 (Special Handling Data/Certification) will be prepared according to figures 13-1 through 13-3 of AFR 71-4/TM 38-250 and will contain the information required by paragraphs 13-3 and 13-4 of the same regulation.

e. Placarding requirements for military aircraft carrying hazardous materials are contained in paragraph 13-5 and table 13-1 of AFR 71-4/TM 38-250.

5-27. Documenting Violation of Regulations

a. SF 364. When required by AR 735-11-2, preservation, packing, marking, and handling deficiencies must be reported on SF 364 (Report of Packaging and Handling Deficiencies). SF 364 will be prepared and distributed as prescribed by AR 735-11-2.

b. SF 361. When required by AR 55-38, cases of over, short, astray, loss of, or damage to military freight; improper loading, blocking, or bracing; improper handling by carrier; tender or use of carrier's

inadequate equipment or facilities; misdirected shipments; documentation errors; or nonobservance of carrier tariff requirements or military regulations must be reported on SF 361 (Discrepancy in Shipment Report (DISREP)). SF 361 will be prepared and distributed as prescribed by AR 55-38.

Section III. MARKING, LABELING, PLACARDING, AND DOCUMENTATION CHECKLISTS

5-28. Use of Checklists

When radioactive materials are being prepared for transport, the following checklists can be used as an aid to assure that marking, labeling, placarding, and documentation are adequate for transport of the materials. Each checklist is designed as a guide to lead the user through a series of questions, the answers to which will lead to the next pertinent question or necessary action to assure adequate preparation for transport. Paragraph 5-29 provides guidance for marking and labeling packages, 5-30 provides a guide for placarding transport vehicles, and 5-31 provides a guide for required documentation.

5-29. Package Marking and Labeling Checklist

This checklist is a guide to ensure that adequate marking and labeling for a package of radioactive materials is required. Question *a* provides for determining whether marking and labeling are required. The remaining questions, each requiring a yes answer, apply to any package that is determined not to be exempt. Necessary actions must be taken to ensure that a yes answer can be given to these questions. Included in parentheses after each question is the applicable text paragraph reference to be used for answering the question.

a. Is the package exempt from marking and labeling requirements? (4-20, 4-21, 4-23, 5-8, 5-9, and 5-10)

b. Does the package conform to general marking requirements? (5-3)

c. For items to be shipped by US mail, are appropriate markings included? (chap 14)

d. Are the labels indicated in the hazardous materials table applied? (49 CFR 172.101)

e. Are the general labeling rules met? (5-5)

f. Is the proper "radioactive" label being used? (5-6)

g. Are all other required labels (because of additional hazards) applied? (5-7)

h. If required, is a radiation hazard symbol affixed? (5-11)

i. For empty containers, is the proper EMPTY label affixed? (5-12)

j. For shipments by military aircraft, are applicable special requirements met? (5-26*a*, *b*, and *c*)

5-30. Placarding Checklist

This checklist provides a guide to assure that appropriate placards are applied to transport vehicles that are used for radioactive materials. Question *a* provides for determining whether placarding is required. The remaining questions, each requiring a yes answer, apply to any shipment that has been determined to require placarding. Necessary actions must be taken to ensure that a yes answer can be given to these questions. Included in parentheses after each question is the applicable text paragraph reference to be used in answering the question.

a. Is placarding of the transport vehicle required? (5-13*a* and *b*, 5-16, and 5-17)

b. Do the placards used conform to regulations? (5-13*c*)

c. If the load is mixed, are all applicable placards affixed to the vehicle? (5-14)

d. Are placards properly applied in the appropriate places? (5-15)

e. For vehicles transported aboard vessels, are special placarding requirements met? (5-16)

f. For shipments transported by military aircraft, are applicable special requirements met? (5-26*e*)

5-31. Documentation Checklist

This checklist provides a guide to assure that shipping papers and other documents are prepared and contain the required information for shipments of radioactive materials. Each question requires a yes answer. The necessary actions must be taken to ensure that a yes answer can be given to these questions before shipment of radioactive materials.

a. For shipments by military aircraft, has DD Form 1387-2 (Special Handling Data/Certification) been completed? (5-26*d*)

b. If required, has SF 364 (Report of Packaging and Handling Deficiencies) been prepared and distributed? (5-27*a*)

c. If required, has SF 361 (DISREP) been prepared and distributed? (5-27*b*)

d. Does the shipping paper contain the necessary generally required entries? (5-18?)

e. Does the shipping paper contain the required certification, and is the certification properly signed? (5-19)

f. For fissile radioactive materials, are all special requirements contained in the shipping papers? (5-20)

g. For export shipments, are the required shipping paper entries completed? (5-21)

h. For air shipments, are applicable special requirements entered on the shipping papers? (5-22)

i. For highway and rail shipments, are placarding requirements entered on the shipping papers? (5-23)

j. For shipments by water, have all necessary additional entries on the shipping papers been made? (5-24)

k. Has the report of shipment or arrival been sent? (5-25)

CHAPTER 6
ACTIONS OF SHIPPERS, RECEIVERS, AND CARRIERS

Section I. GENERAL

6-1. Purpose

This chapter outlines the general requirements for action by shippers (consignors), receivers (consignees), and carriers of radioactive material. Federal, State, and municipal regulating agencies enact changes to regulations and statutes daily. Adverse publicity and fines result from strict enforcement of these changes. It is the duty of the installation transportation officer (ITO) to have the shipment in compliance with the latest changes when the shipment is released for transport and the certification is signed. The ITO is held responsible for compliance and inspection of all packages and documentation for shipments of radioactive material.

6-2. Organization and Use

Section II contains the rules and regulatory requirements (cross-indexed to the appropriate regulations or document). Section III contains checklists that may be used to ensure that required actions are accomplished.

Section II. RULES AND REGULATORY REQUIREMENTS

6-3. Shipments Rules and Procedures (AR 385-11)

a. Shipments of all radioactive materials will be arranged by the installation transportation officer. The ITO will ensure that all the required coordination is accomplished and will take such other actions as required under existing regulations.

b. The transportation officer will assure that all external characteristics of the container(s) are fully acceptable and comply with all regulatory requirements for the commodity described by the radiation protection officer's statement. Transportation officers will not accept or offer for shipment visibly inadequate, damaged, or leaking package(s) or container(s). The transportation officer will assure that tiedowns are adequate before any radioactive materials are moved by car or truck.

6-4. General Rules for Highway Movement (Chap 11)

a. Shipments by commercial motor vehicles will be made according to applicable DOT regulations. Additional safety requirements may be specified by Army regulations.

b. Highway shipments requiring escorts will be made only by carriers approved by MTMC to handle ammunition and explosives, classes A and B, or by carriers with equal safety standards.

6-5. General Rules for Rail Movement (Chap 12)

a. Rail movements of radioactive materials will be made according to applicable DOT regulations. The authority to formulate regulations for the safe transport of explosives and other dangerous articles by land in the United States is vested in DOT.

b. Escorted shipments of radioactive materials will be made according to the rules and regulations of DOT and DA. Expedited service (MTX Symbol) is required and will be obtained as provided in paragraph 39-9*b*(1), AR 55-355. Each shipment will be handled as a separate transaction.

6-6. General Rules for Air Movement (Chap 10)

a. All commercial air shipments of radioactive material will be made according to applicable FAA regulations.

b. They also will be made according to such other rules and regulations as may be prescribed by appropriate regulatory bodies and the military services concerned.

c. Air movement to overseas destinations will be governed by the provisions and procedures in AR 55-16.

d. When radioactive materials, other than weapons, are scheduled for commercial air shipment

within CONUS, including movement to an aerial port for transshipment overseas, the transportation officer at origin will arrange the movement as specified in AR 55-355 or AR 55-16.

6-7. General Rules for Ocean Movement (Chap 13)

a. All water movements of radioactive materials will be made according to applicable US Coast Guard (USCG) regulations.

b. Escorted shipments of radioactive materials will be handled under normal "export release" procedures.

6-8. General Rules for US Mail Movement (AR 385-11 and Chap 14)

a. Shipment by US mail and/or parcel post will be checked by the installation radiation protection officer. He will ensure that all required coordination is made and that all postal regulations are complied with.

b. Chapter 14 contains the shipping details.

6-9. General Rules for Loading

a. Quantity, radiation level, dose, and contamination limitations described in chapters 3 and 4 must not be exceeded. Before loading, the radiation levels and spreadable surface contamination will be surveyed.

b. Radioactive materials must not be loaded, transported, or stored with any of the following (49 CFR 177.842 and 177.848):

(1) Low explosives or black powder.

(2) High explosives or propellant explosives, class A.

(3) Initiating or priming explosives, wet: diazodinitrophenol, fulminate of mercury, guanyl nitrosamino guanylidene hydrazine, lead styphnate, nitro mannite, nitrosoguanidine, pentaerythrite tetranitrate, tetrazene, and lead mononitroresorcinate.

(4) Blasting caps, with or without safety fuse (including electric blasting caps), and detonating primers.

(5) Ammunition for cannon with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles, or shell; ammunition for small arms with explosive bullets; ammunition for small arms with explosive projectiles; rocket ammunition with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, or illuminating projectiles; boosters (explosive); bursters (explosive); and supplementary charges (explosive) without detonators.

(6) Explosive projectiles; bombs; torpedoes; mines; rifle or hand grenades (explosive); jet thrust units (jato), class A; rocket motors, class A; and igniters, rocket motor, class A.

(7) Detonating fuzes, class A, with or without radioactive components.

(8) Blasting caps, 1,000 or fewer, with or without safety fuse (including electric blasting caps), and detonating primers.

c. Radioactive materials may be loaded with other compatible cargo to economize on available equipment space. However, *no types of radioactive materials will be loaded in the same vehicle or compartment of an aircraft or ship with vegetables, fruits, bagged grains, or other contaminable foodstuffs.* Compliance with loading and storage charts (*b* above) contained in 49 CFR 171-179 and AFR 71-4/TM 38-250 is mandatory. Care must be exercised to prevent loading or handling of packages labeled Radioactive Yellow-II or Radioactive Yellow-III near photographic film and supplies, to prevent radiation damage to such film and supplies.

d. The shipment will be loaded so as to prevent loss, dispersal, or shifting of loading under normal transport conditions.

e. Shipments of low specific activity (LSA) materials must be loaded so as to avoid spillage and scattering of loose materials (49 CFR 177.842 and 174.700).

f. Shippers must furnish the material for restraining packages of dangerous articles loaded by them.

g. When radioactive materials are loaded by the shipper or are unloaded by the consignee, the shipper or consignee must observe all applicable requirements, including application or removal of placards or car certificates (49 CFR 172.504 to 172.558).

h. A railcar placarded RADIOACTIVE MATERIALS in a freight train or mixed train, either standing or during transport, must not be placed next to cars placarded EXPLOSIVES or next to carload shipments of undeveloped film.

i. The number of packages of radioactive materials in any railcar, motor vehicle, trailer, aircraft, or storage place must be limited so that the total transport index (the sum of the transport indexes on the individual packages) does not exceed 50. This provision does not apply to sole-use shipments.

j. The shipping agency must lift and move heavy cask(s) of radioactive material when it has the necessary hoisting equipment. If the agency has no such equipment, it will arrange with an appropriate support element for hoisting equipment. The shipper will furnish the support element with the weight and size of the cask(s) to be moved and any special movement instructions. The supporting element providing the hoisting equipment will lift the cask(s) onto or off transport carriers.

6-10. General Requirements for Routing of Shipments

Routing of radioactive materials shipments requiring technical escort will be carefully planned, scheduled, and coordinated by the shipper in advance of actual movement. Such shipments will be routed to avoid densely populated areas to the *maximum extent possible*. Transportation costs will not be the controlling factor for routing shipments, and costs will be considered only after the above requirements are complied with.

6-11. Requests for Routing (AR 55-355)

Routing requests for use of commercial motor vehicular service and commercial rail equipment will be forwarded by the shipping installation to the appropriate area Commander, Military Traffic Management Command, as provided in AR 55-355. Requests should be forwarded far enough in advance of the required shipping date to allow for the equipment inspection and other requirements for the movement. The following information will be included with all requests for commercial routing of shipments:

a. Name of materials (isotopes involved and activity of each).

b. Number of packages, with total weight and cube.

c. Security classification, if any.

d. Commodity description, including the radiation level of each package and any other hazards for which specific safeguards may be required.

e. Point of origin and proposed shipping date.

f. Consignor.

g. Consignee.

h. Special conditions of shipment approval, if any.

6-12. Export and Import Shipments (49 CFR 177-179)

a. General.

(1) Export or import shipments of radioactive materials offered for domestic transport will be properly packaged, marked, labeled, and described, as prescribed by DOT regulations.

(2) Quantity limitations or exemptions also apply to import and export shipments by all modes and means of transport.

(3) Except for the requirements of 49 CFR 177.817 and 177.823, transport by motor vehicle or water to effect transfer of import/export shipments within a port area, including contiguous harbors, is exempt from the provisions of DOT regulations.

b. Packaging.

(1) Foreign-made packagings that bear the symbol "Type A" may be used to transport radioactive materials to their destination in or by way of the United States (44 CFR 173.415(d)).

(2) Packages consigned for export are also subject to the regulations of foreign governments involved in the shipment (49 CFR 171.12).

(*a*) The shipper must determine that this package meets all the requirements of the foreign countries involved. He must present the basis of his evaluation and certify that he has made the determination and those standards have been met.

(*b*) The DOT will act as the competent authority in providing the certificate required by IAEA regulations for special permits for radioactive materials packages. Requests for special permits will be forwarded through appropriate command channels to the Commander, MTMC.

c. Labeling. Labels that conform to the model prescribed in the IAEA regulations and that are similar to the labels prescribed herein (although the label inscriptions may be in a foreign language) are authorized in place of the labels prescribed herein for import or export shipments only (49 CFR 172.436 or 172.440).

d. Canadian Shipments. Radioactive shipments that conform to the regulations of the Canadian Transport Commission may be transported to their destination in the United States or by way of the United States to Canada (49 CFR 173.8). Canadian regulations for shipment of radioactive materials by rail (freight or express), sea, or air transport are essentially identical to those of DOT, including arrangement and numbering. Special permits or other special arrangements are approved by the Canadian Transport Commission. Canadian regulations governing the transport of dangerous and hazardous materials are contained in the following publications.

(1) *Manual for Supply and Transport*, Volume I, Section 12.

(2) *Canadian Transport Commission*, Article 73.391.

(3) *Canadian Forces Pamphlet 117*, Article 1051.

(4) *IATA*, Article 1529.

(5) "Recommended Precautions to be Taken for Safety in the Carriage of Radioactive Material in Ships," issued by Chairman, Board of Steamship Inspection, 10 September 1952; revised 1966.

6-13. General Duties of Carriers

a. Reporting of Improperly Packed or Damaged Shipments. Carriers must report immediately to the shipper and DOT, or to the Commandant of the Coast Guard, as appropriate, all instances of the following:

(1) Packages or shipments of hazardous articles that are not properly prepared for transport, whether discovered before or during transport.

(2) Accidents involving damage to containers of hazardous articles, which require repacking of the articles.

(3) Serious violations of regulations, such as defective packing, improper restraint, or rough treatment of cars.

b. Reporting of Certain Hazardous Materials Incidents. Incidents/accidents involving radioactive materials require immediate and detailed reports by the carrier, as specified by 49 CFR 171.15 and 171.16. Also, such incidents and/or accidents require the notifications specified in 49 CFR 174.750 (rail), 175.45 (aircraft), 176.48 (vessels), and 177.861 (vehicles). The requirements and format for reporting, to the US Coast Guard, incidents/accidents aboard vessels in the navigable waters of the United States are contained in 46 CFR 2.20-65. The requirements for a detailed followup report are contained in 46 CFR 2.20-70.

c. Labels and Placards (49 CFR 177 to 179). DOT regulations require carriers to keep on hand an adequate supply of labels and placards. Carriers must replace labels or placards lost or detached in transit. They must also supply placards or markings on all vehicles loaded by them.

6-14. Requirements for Picking Up, Receiving, and Opening Packages (10 CFR 20.205)

a. A consignee who expects to receive a package that contains quantities of radioactive materials in excess of the Type A quantities specified in table 2-2 shall:

(1) If the package is to be delivered to the consignee's facility by the carrier, arrange to receive the package when it is delivered.

(2) If the package is to be picked up by the consignee at the carrier's terminal, arrange to be notified by the carrier when the shipment arrives.

(3) If the package is to be picked up by the consignee at the carrier's terminal, pick up the package promptly when notified by the carrier that the package has arrived.

b. The consignee, upon receipt of a package of radioactive material, shall monitor the external surfaces of the package for radioactive contamination caused by leakage of the contents. This monitoring shall be done as soon as practicable, but no later than 3 hours after receipt at the consignee's facility if received during normal duty hours, or 18 hours if received after normal duty hours. This monitoring requirement extends to all packages except those that contain:

(1) No more than the limited quantities outlined in paragraph 2-20.

(2) No more than 10 millicuries of radioactive material consisting solely of tritium, carbon-14, sulfur-35, or iodine-125.

(3) Only radioactive material as gases or in special form.

(4) Only radioactive material in other than liquid form (including Mo-99/Tc-99m generators) and not exceeding the Type A quantity limit specified in table 2-2.

(5) Only radionuclides with half-lives of less than 30 days and a total quantity of no more than 100 millicuries.

c. If the monitoring specified in *b* above results in finding removable radioactive contamination in excess of 2200 dpm (beta-gamma) or 220 dpm alpha per 100 square centimeters of package surface on the external surfaces of the package, the consignee shall immediately notify:

(1) The final delivering carrier, and

(2) By telephone and telegraph, mailgram, or facsimilie, the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office shown in table 6-1.

d. The consignee, upon receipt of a package containing quantities of radioactive material in excess of the Type A quantities specified in table 2-2 (except for those transported by exclusive-use vehicles), shall monitor the radiation levels external to the package. The package shall be monitored as soon as practicable after receipt, but not later than 3 hours when received during normal duty hours and not later than 18 hours when received after normal duty hours.

e. If the monitoring specified in *d* above results in finding radiation levels on the external surface of the package in excess of 200 millirems per hour or, at 3.3 feet from the external surface, in excess of 10 millirems per hour, the consignee shall immediately notify:

(1) The final delivering carrier, and

(2) By telephone and telegraph, mailgram, or facsimilie, the director of the appropriate NRC regional office listed in table 6-1.

6-15. General Rules for Unloading Shipments (AR 385-11)

a. All motor vehicles containing radioactive materials will be inspected before unloading. Any deficiencies will be corrected at the time of inspection, if practicable and if required for safe delivery to the unloading point. If correction of the deficiencies is required, but impracticable, proper action will be taken to ensure safe delivery of the shipment.

b. Before unloading, any closed compartment in which a radioactive shipment has been carried will

Table 6-1. United States Nuclear Regulatory Commission Inspection and Enforcement Regional Offices

Region	Address	Telephone Daytime, Nights, and Holidays
I Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont	Region I, USNRC Office of Inspection and Enforcement, 631 Park Avenue, King of Prussia, PA 19406–1498	(215) 337-5000
II Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, and West Virginia	Region II, USNRC Office of Inspection and Enforcement, 101 Marietta St, Suite 2900 Atlanta, GA 30323	(404) 331-4503
III Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, and Wisconsin	Region III, USNRC Office of Inspection and Enforcement, 799 Roosevelt Rd, Glen Ellyn, IL 60137	(312) 790-5500
IV Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington and Wyoming	Region IV, USNRC Office of Inspection and Enforcement, 1990 N California Blvd, Suite 202, Walnut Creek, CA 94596	(415) 943-3700

be adequately ventilated to remove gases that may have collected.

c. Upon receipt and before unloading of radioactive materials from a car, vehicle, or aircraft at a receiving installation, the package(s), under the supervision of the installation health physicist or radiation protection officer, will be carefully monitored for excessive external radiation or contamination. If excessive radiation is present, the car, vehicle, or aircraft will be isolated and appropriate measures taken to ensure minimum exposure of personnel engaged in unloading operations.

d. All vehicles (military and commercial) and aircraft that have transported radioactive materials will be carefully monitored, under the supervision of the installation health physicist or radiation protection officer, for radioactive contamination immediately after the radioactive items are unloaded. The vehicle or aircraft must be decontaminated before release if the contamination exceeds the levels given in paragraph 3-9. A certificate to this effect will be issued by the ITO to the common carrier or for the vehicle or aircraft operation. If contamination is greater than the above limits, vehicles or aircraft and terminal equipment and personnel used in transshipment will be checked, as far back as necessary, to determine the extent of property and personnel contamination. Detection of such contamination levels indicates an accident has occurred and will be reported as described in paragraph 6-14 and chapter 7.

NOTE

Vehicles and cars that are used solely for the transport of radioactive materials are exempt from the above-stated requirements provided the requirements in paragraph 3-4 are met.

e. Damaged or contaminated shipments will under no circumstances be rejected by the carrier. Steps must be taken to minimize exposure of personnel and contamination of property.

f. Upon receipt of a shipment at the receiving installation, the radiation protection officer will record the condition of the shipment and dose rate levels of radiation.

g. Placards and car certificates, if applicable, must be removed when the car is unloaded.

h. The receiving agency will unload heavy cask(s) of radioactive materials when it has the necessary hoisting equipment. If the agency has no such equipment, it will arrange with an appropriate support element for hoisting equipment. It will furnish the support element with the weight and size of cask(s)

to be moved and any special movement instructions. The support element providing the hoisting equipment will lift the heavy cask(s) onto or off transport carriers.

6-16. Special Requirements for Movement of Fissile Materials, Including Irradiated Fuel Elements (10 CFR 71, 49 CFR 173.448 through 173.459, AR 385-11, and TM 55-4470-400-12-1)

a. Fissile radioactive material packages are classified according to the controls needed to provide nuclear criticality safety during transport, as indicated in paragraph 2-17.

b. Packaging of fissile radioactive materials will conform to the requirements in paragraphs 4-13 through 4-17.

c. Before movement, the NRC will approve the packaging for the movement of licensed materials, including fissile materials, irradiated fuel elements, and "large quantities" of radioactive materials. Any of these items requiring movement as a matter of national security are exempt from this provision and will be moved under the authority of the Secretary of Defense, with appropriate certification to NRC.

d. Fissile Classes I and II shipments that conform to NRC and DOT, FAA, or USCG regulations, as applicable, normally can be shipped without further control.

e. Mixing of packages of other types of radioactive material, including Fissile Class I with Fissile Class II packages, is permitted if the total transport index in any one transport vehicle or storage location does not exceed 50.

f. For Fissile Class II packages shipped under the sole-use provision of paragraph 4-14 to provide for packages with high radiation dose rates, the transport index, which is calculated for nuclear criticality control purposes, must not exceed 10 for any single package or a total of 50 for the full load, unless specifically authorized by DOT for Fissile Class III shipments.

g. Fissile Class III shipments may be made only according to (1) or (2) below, or according to other procedures authorized by DOT.

CAUTION

The transport controls must provide nuclear criticality safety and will be carried out by the shipper or carrier, as appropriate, to protect against loading, transporting, or storing of that shipment together with other fissile material (49 CFR 173.396).

(1) Transport in a vehicle assigned for the sole use of that consignor, with a specific restriction for such sole use to be provided in the special arrangements, and with instructions to that effect issued with the shipping papers; or

(2) Transport under escort by a person in a separate vehicle, with the escort having the capability, equipment, authority, and instructions to provide administrative controls adequate to assure compliance with this manual.

h. When escorted Class III shipments of fissile materials are moved by any transport mode, the escort will be carefully briefed, by the transportation officer or other qualified person of the shipping installation, on the inherent danger in the loading and the necessity for maintaining the original load configuration. The escort commander also will be given written instructions confirming the oral instructions. If no escort is assigned to a shipment, the truck driver, aircraft commander, or train conductor will be briefed and furnished written instructions on the inherent dangers of the material and the necessity for maintaining the original load configuration.

i. Fissile Class III shipments generally will not be transshipped en route. If transshipment is required because the carrier cannot continue to the destination, the shipping installation will be notified immediately. The consignor's ITO will coordinate with the Army commander and/or military installation nearest the transshipment point to assure that the material is safely transferred and that the equipment on which the material is loaded is properly inspected for transport of the material.

Section III. CHECKLISTS

6-17. Use of Checklist

When shipment of radioactive materials is considered or planned, the following checklist can be used as an aid to assure that all required actions and other considerations are accomplished before the actual movement. The checklist is designed as a guide to lead the user through a series of questions, each requiring a yes answer to assure compliance. This checklist will refer the user to other detailed checklists as appropriate. Paragraph references appear after each question.

6-18. Checklist

a. General Planning Checklist.

(1) Have general shipment rules been met? (6-3)

(2) Has required routing planning been accomplished? (6-10)

(3) Has a routing request been submitted? (6-11)

(4) Have required arrangements for pickup, receipt, and opening of packages been made? (6-14*a*(1), (2))

(5) If required, have technical escort services been provided for? (7-12 through 7-14)

(6) Have provisions been made to ensure dissemination of instructions/procedures to be followed in accident or incident situations? (chap 7, sec III)

(7) If applicable, have provisions been made for security of special nuclear material during transit? (chap 8)

(8) Is an adequate quality assurance program in effect? (chap 9)

b. Receiving and Unloading Checklist.

(1) Have requirements for pickup, receipt, and opening of packages been met? (6-14)

(2) Have unloading rules been met? (6-15)

(3) Are packaging requirements met? (See packaging checklists, para 4-25.)

(4) Are packages properly marked, labeled, placarded, and documented? (See marking, labeling, placarding, and documentation checklists, paras 5-28 through 5-31.)

c. Shipping Checklists.

(1) Have all packaging requirements been met? (4-25)

(2) Are packages properly marked, labeled, placarded, and documented? (5-28 through 5-31)

(3) Have general rules for loading been complied with? (6-9)

(4) Has carrier demonstrated ability to comply with general duties of carrier? (6-13)

(5) For shipments of fissile materials, are all special requirements met? (6-16)

(6) For export/import shipments, are all applicable special requirements met? (6-12)

(7) For US mail shipments, have general rules for movement by mail been complied with? (6-8)

(8) For highway shipment, have general rules for movement by highway been met? (6-4)

(9) For highway shipment, has highway checklist been completed? (11-15)

(10) For rail shipment, have general rules for movement by rail been met? (6-5)

(11) For rail shipment, has rail checklist been completed? (12-11)

(12) For air shipment, have general rules for movement by air been met? (6-6)

(13) For air shipment, has air movement checklist been completed? (10-17)

(14) For water shipment, have general rules for ocean movement been met? (6-7)

(15) For water shipment, has water movement checklist been completed? (13-14)

(16) For shipments of special nuclear material, have all applicable requirements for in-transit security been met? (chap 8)

(17) For all shipments, have appropriate personnel been briefed on procedures to follow in accident/incident situations? (chap 7, sec III)

(18) If required, is technical escort available? (chap 7, sec III)

CHAPTER 7
SAFETY IN TRANSIT

Section I. GENERAL

7-1. Purpose and Scope

This chapter describes procedures to ensure safety of personnel and equipment and to identify and cope with any radiological emergency that may occur during transit. A radiological emergency is any unplanned event that could adversely affect the safe movement of radioactive materials. A severe emergency could result from a collision, fire, or explosion involving the cargo; or from theft, spillage, leakage, misplacement, or loss of control of the cargo. Overexposure and contamination of personnel and property could be the end result.

7-2. Organization and Use

Section II of this chapter outlines the procedures to follow in accident or incident situations. Section III details procedures to provide for technical escorts of shipments that require them.

7-3. Definition of Accident/Incident

A Department of the Army accident is defined in AR 385-40. For this manual, accidents and incidents involving radiation and fissile materials other than weapons are defined below:

a. Accidents. Any physical damage to the containers, any overexposure of personnel, contamination of a person in any detectable amount, or contamination level stated in paragraph 3-11.

b. Incidents. Unexpected events that are not accidents, as defined in *a* above, but that may increase in hazard severity or, if the unsafe practice or condition is not corrected, may result in an accident. Incidents include errors committed in handling operations, which may result in radiological exposure to personnel or material; malfunction of transport equipment, which might result in danger to the lading if not corrected; or malfunction of the container or associated equipment components, which degrades safety.

Section II. PROCEDURES TO FOLLOW IN ACCIDENT/INCIDENT SITUATIONS

7-4. General Guidance

The prime objective of emergency action is to protect personnel from the hazards of radiation and contamination. A secondary objective should be to confine the contamination to the local area of the accident. Although no set of rules is available to handle every conceivable incident, the proper adaptation of the more specific guidance furnished below will minimize the danger to personnel and property. In case of a serious accident involving nuclear or radioactive materials, the ranking person (guard, courier, escort, or transportation personnel) accompanying the shipment will take immediate steps to clear the area and request assistance. If there is reason to believe that personnel may have been contaminated and/or overexposed, efforts will be directed toward finding those persons so that any required decontamination and medical assistance may be furnished. In the case of an accident/incident involving fissile material, the potential hazard of criticality exists, particularly during cleanup. Therefore, the advice of a qualified criticality engineer should be obtained about an accident/incident involving fissile materials.

7-5 Actions in Emergencies Involving Collision Fire Explosion, Leakage, or Spills

Danger - Personnel overexposure could result from increased dose rates. Contamination of property and equipment could occur.

a. Immediate Actions.

(1) Minimize emergency, if possible. Extinguish fire with dry-chemical fire extinguisher.

(2) Use onsite assistance to:

(*a*) *Establish Exclusion Area.* Increase distance shown on DD Form 836 to keep personnel out of smoke, leakage, spillage, or mists.

(*b*) *Render First Aid.* Inform medical personnel that injured personnel may be contaminated.

(c) *Control Personnel Who May Be Contaminated.*

1. Obtain names and addresses.

2. Discourage smoking, eating, drinking, and leaving until monitoring and decontamination assistance is available.

(3) Localize contamination. *Example*: Leakage and spillage on highway can be removed by sweeping or shoveling contaminated material into a suitable container and holding for disposal. If liquid has been spilled, the contamination may be contained by means of dirt, cloth, sawdust, or other absorbent material. Dusts can be settled by means of a fine water spray. Appropriate radiation monitoring should accompany these actions.

b. Subsequent Actions.

(1) The responsible person at the scene, after taking the emergency action required to protect personnel and property, will report by telephone to the nearest military or Department of Energy (DOE) (fig 7-1) installation and, if needed, will request aid. The person will also request that the Army area be notified. If there are no nearby military or DOE installations from which help can be secured, a telephone report and request for aid will be made to the headquarters of the Army area in which the accident/incident occurred (table 7-1). Appropriate telephone numbers to call for assistance will be included in the written instructions provided to the driver or escort commander.

(2) Local police authorities may be called upon to assist in the control of the area and to exclude the public, to prevent possible radiation exposure until authorized Army control can be established.

(3) If the shipment is unescorted, the driver or conductor will be instructed to obtain assistance at the scene to maintain exclusion of the area until other assistance is available. In the event of a fire, contact local fire department.

(4) Monitor and decontaminate personnel, if necessary. See paragraph 7-7 for guidance on decontamination of personnel. Assistance from local health department, civil defense, nearest chemical biological radioactive team, or other regional accountable depot safety team may be required.

(5) Monitor and decontaminate property. (Same assistance as (4) above may be necessary.) Reduce exclusion area to bare minimum.

(6) Document the emergency.

(7) Accidents or incidents that occur in transit shall be reported by the carrier to the Department of Transportation as required by 49 CFR 171.15 and 171.6.

7-6. Procedures in Case of Theft or Loss

a. Notify Army area headquarters (table 7-1).
b. Notify consignor.
c. Notify FBI and local police officials.
d. Attempt to recover.

7-7. Decontamination of Personnel

a. If packages were undamaged, contamination is unlikely. However, radiac instruments are needed to verify the presence or absence of contamination. For beta-gamma materials, a Geiger Mueller-type instrument capable of distinguishing exposure rates between 0 and 0.2 milliroentgen per hour is needed. For alpha-emitting materials, an instrument capable of detecting 500 alpha particles per minute per 16 square inches is required. Further, it should be noted that alpha radiation cannot be detected on moist or wet surfaces.

b. Washing in lukewarm water with nonabrasive soap is the best general method to decontaminate the hands and other parts of the body, regardless of contaminant. If the contaminant is localized, it is often more practical to mark off the affected area and cleanse with swabs, rather than to risk the danger of spreading the contaminant by general washing.

CAUTION

Organic solvents must be avoided as decontaminating agents because they may increase the probability of the radioactive materials penetrating through the pores of the skin. Special attention must be given to the areas between the fingers and around the nails; also, the outer edges of the hands are readily contaminated and often neglected in the washing.

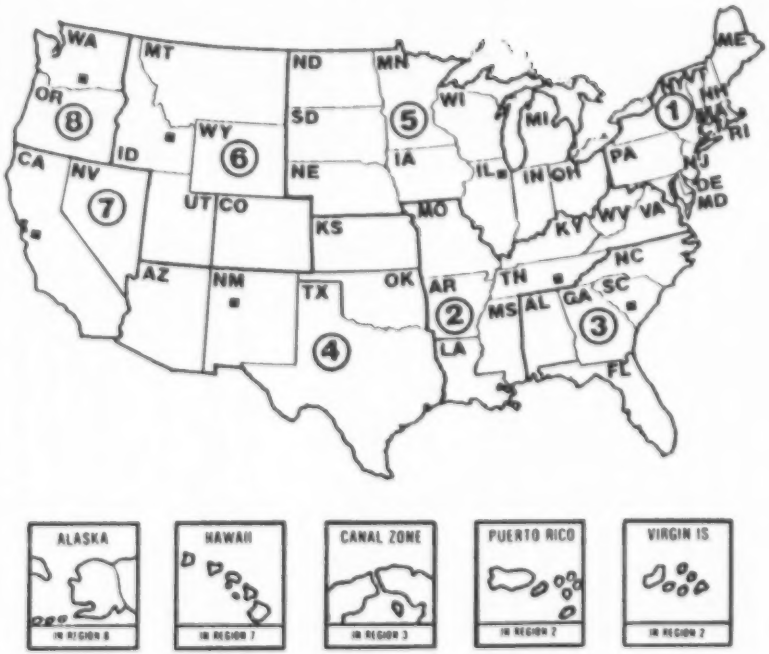
Table 7-1. Army Headquarters

Army	Address	Telephone for assistance AUTOVON	Area Code	Local No.
First	Fort George G. Meade, MD 20755–7000	923-1110	301	677-6261
				677-6262
Fifth	Fort Sam Houston, TX 78234–5000	471-1110	512	221-1211
Sixth	Presidio, San Francisco, CA 94129–5190	586-1110	415	561-2211
MDW*	Fort Meyer, VA 22211	227-0101	202	545-6700

* Military District of Washington

DEPARTMENT OF ENERGY

REGIONAL COORDINATING OFFICES FOR RADIOLOGICAL ASSISTANCE AND GEOGRAPHICAL AREAS OF RESPONSIBILITY



	REGIONAL COORDINATING OFFICE	POST OFFICE ADDRESS	TELEPHONE FOR ASSISTANCE
1	BROOKHAVEN AREA OFFICE	UPTON, LI NY 11973-5000	(516) 282-2200
2	OAK RIDGE OPERATIONS OFFICE	P.O. BOX E OAK RIDGE, TN 37831-2001	(615) 576-1005 OR (615) 525-7885
3	SAVANNAH RIVER OPERATIONS OFFICE	P.O. BOX A AIKEN, SC 29801-1022	(803) 725-3333
4	ALBUQUERQUE OPERATIONS OFFICE	P.O. BOX 5400 ALBUQUERQUE, NM 87115-5400	(505) 844-4667
5	CHICAGO OPERATIONS OFFICE	9800 S. CASS AVE ARGONNE, IL 60439-4897	DUTY HOURS (312) 972-4800 OFFICE HOURS 972-5731
6	IDAHO OPERATIONS OFFICE	785 DOE PLACE IDAHO FALLS, ID 83401-3958	(208) 526-1515
7	SAN FRANCISCO OPERATIONS OFFICE	1333 BROADWAY OAKLAND, CA 94612-1874	(415) 273-4237
8	RICHLAND OPERATIONS OFFICE	P.O. BOX 550 RICHLAND, WA 99352-0550	(509) 373-3800

Figure 7-1. Department of Energy regional coordination offices for interagency radiological assistance plan and geographical areas of responsibility.

c. If several persons have become contaminated or the contamination on a person is not localized to a small portion of the body, the following decontamination procedures will be used:

(1) The person will stand under a tepid shower.

(2) Using a mild toilet soap, the person will cover entire body with lather.

(3) While still covered with lather, the person will step out of shower.

(4) An assistant will sprinkle a heavy coat of mild soapflakes all over the lathered person. (Purpose of lather is to cause soapflakes to adhere to person.)

(5) Using his hands, the contaminated person will rub the soapflakes on his body into a paste.

(6) The person will then return to shower and rinse soap off his body, starting at the top and working down.

NOTE

The person must rub body surfaces with his hands while rinsing to remove soap paste. Soap paste will remain in those areas that have not been thoroughly washed. Although a soft cloth may be used, a brush may not. Particular attention should be given to hairy portions of the body.

(7) When the person has rinsed himself to the point that he no longer feels slimy and while still under shower, an assistant will examine him for traces of soap. The presence of soap will indicate which areas of the body have not been decontaminated.

(8) After removing all traces of soap, the person will leave the shower and dry off.

(9) After drying off, the person will be monitored. If he is still generally contaminated, procedures will be repeated.

7-8. Action to be Taken in Case of an Accident Involving Radioactive or Fissile Materials (AR 385-40)

The senior person will:

a. If radioactive materials are exposed or if contamination is suspected, establish an exclusion area to prevent the general public from inadvertent exposure to radiation or contamination. Accept local assistance if required. The exclusion area will be maintained until the appropriate radiological team certifies that the danger is past.

b. Take such other emergency action as the situation requires (rescue operations, firefighting, and so forth).

c. Notify the nearest military installation and request immediate assistance, giving pertinent information as follows:

(1) Location and nature of accident.

(2) Emergency procedures initiated.

(3) Type of materials involved and help required.

d. Request that shipping installation be notified at earliest possible time.

e. Notify, by telephone or electrical means, HQDA (DACS-FS, AUTOVON 225-7291, and DASG-PSP-E, AUTOVON 289-0132) and HQ USAMC (AMCSF-P, AUTOVON 284-9340). Also notify the Commander, MTMC (MT-SS, AUTOVON 289-1109). During nonduty hours, notify the Army Operations Center (AUTOVON 225-0441), indicating which offices must be notified.

f. Prepare an on-the-scene report, which will detail all pertinent factors contributing to the accident and the emergency measures taken to protect personnel and property. This report will be submitted within 24 hours to the safety office of the shipping installation, with copies to the Deputy Chief of Staff for Personnel, ATTN: DAPE-HRS, Department of the Army, Washington, DC 20310–0300; the Commander, MTMC, ATTN: MT-SS, Falls Church, VA 22041–5050; and to the safety officer of the Army installation providing assistance. If military vehicles are involved, this report will be made in addition to the reports required by AR 385-40.

7-9. Action to be Taken in Case of an Incident Involving Radioactive or Fissile Materials

The senior person present will:

a. Take the required precautions to protect personnel and property and to prevent development of the incident into an accident.

b. Notify the nearest military installation and request assistance if required.

c. Notify the shipping installation and request instructions to safely complete mission.

d. Prepare an on-the-scene report, which will detail the emergency measures taken and the assistance requested and rendered to reduce the incident.

e. Report incidents to the safety director of the shipping installation within 24 hours. The safety officer will submit a written report within 5 days to the Deputy Chief of Staff for Personnel, ATTN: DAPE-HRS, Department of the Army, Washington, DC 20310–0300; the Commander, MTMC, ATTN: MT-SS, Falls Church, VA 22041–5050; and to such other command levels as required.

7-10. Control of Release of Information

a. Reports indicated in paragraphs 7-8 and 7-9 will not be given to local police officers or to representatives of the press. The senior person present will make such answers to the local police as are required by law to complete their report but will not discuss the nature of the lading except to indicate the need for the required safety measures taken.

b. Relations with the press and release of information to the public concerning nuclear accidents and incidents will be governed by AR 360-5.

7-11. Interagency Radiological Assistance

a. The Federal Interagency Radiological Assistance Plan, whose main proponents are the Department of Defense and the Department of Energy (DOE), provides the procedures and the resources for the expeditious supply of effective radiological assistance to anyone requesting it in case of a radiological accident/incident. This plan is administered for the military services through the Joint Nuclear Accident Coordination Center (JNACC), located in Washington, DC.

b. Any military or DOE installation receiving a request for radiological aid will contact, according to existing plan, the *appropriate* higher headquarters to initiate action under the JNACC procedures.

(1) The Army headquarters with jurisdiction in the area of the accident will be notified. Army area headquarters, with addresses and telephone numbers, are given in table 7-1.

(2) DOE Regional Office areas of responsibility for radiological assistance in accidents/incidents involving radioactive materials, together with the addresses and telephone numbers, are listed in figure 7-1.

Section III. TECHNICAL ESCORTS

7-12. Requirements for Escorts

a. Shipments made according to Section 832C of the Transportation of Explosives Act (18 USC 832C) for national security will require technical escort. Technical escorts will be used when required by AR 385-11 or at any time that the responsible commander considers it appropriate. The technical escort, when used, will accompany a shipment of radioactive materials in a separate vehicle (highway or railcar).

b. Provisions for the use of technical escorts (as distinguished from military guards) and vehicles, when needed, together with appropriate orders to assure the continuous technical surveillance and safety of the material during the movement is the responsibility of the originating installation.

c. Military guards, when necessary for protection of Army radioactive materials (chap 8), will be arranged for according to AR 380-55.

d. Classified shipments will be made according to AR 380-55.

7-13. Composition and Capabilities of Technical Escorts

a. Technical escorts (AR 385-11 and AR 740-32) will consist of personnel from the US Army Technical Escort Unit (USATEU, ATTN: SMCTE, APG, MD 21010) or qualified and responsible DA military or civilian personnel. Escorts will have a security clearance equal to the highest security clearance of the material they are to escort. The escort personnel radiation training and experience and the radiac equipment must be equal to the radiological hazard of the material being shipped.

b. Besides radiation safety equipment, technical escorts will include as part of their equipment one fire extinguisher with a minimum Underwriter Laboratories (UL) rating at 4 A 30 B:C and one multipurpose fire extinguisher with a minimum UL rating of 10 A 40 B:C. In highway movement, the multipurpose fire extinguisher will be carried on the escort vehicle and the 4 A 30 B:C fire extinguisher on the commodity transport vehicle, within reach. In rail shipment, the firefighting equipment will be carried in the railcars in which the escorts travel. Escort personnel will be able to operate all firefighting equipment issued.

7-14. Procedures for Obtaining Technical Escort Service From the USATEU (AR 385-11)

Installations requiring technical escort service will furnish quarterly schedules (to cover subsequent two quarters) to Cdr, AMCCOM, ATTN: AMSMC-RDP-O, Rock Island, IL 61299–6000, for all known or expected moves. (Include data required by AR 740-32.) Detailed information for each move should be sent to Cdr, USATEU, ATTN: SMCTE, Aberdeen Proving Ground, MD 21010.

a. A minimum of 7 days before the desired shipping date, for CONUS shipments.

b. A minimum of 60 days before the shipping date, outside CONUS. Emergency requests should be made by the quickest means, followed by confirmation in writing.

c. The following information (minimum) is required for each move:

(1) Items and quantity to be shipped, to include:

(*a*) Shipping dimensions (length, width, and height) and weights.

(*b*) Security classification of shipment.

(*c*) Radioactive items to include:

1. Solid, liquid, or gas.

2. Most hazardous radioisotopes to be shipped.

3. Amount of radioactivity – that is, number of curies, millicuries, or microcuries of radioactive items per container – and type of instrument used to determine readings.

4. Routing of shipment (para 6-11).

5. Distance of outer container(s) and duration that may be continuously occupied by personnel (tables 10-1, 11-1, 12-1, and 13-1 and figure 13-1).

(*d*) Outside shipping container.

1. Number of containers to be shipped.

2. Containers, DOT permit, number, list number, and limitations of permits, if applicable; if none, so indicate.

3. Total weight and shipping dimensions of packaged containers.

4. Surface readings of radioactive items inside container, and type of instrument used to determine readings.

5. Surface and 1 meter (3 feet, 3 inches) from surface readings, in rems, of each primary container, and type of instrument used to determine readings. If there is no detectable reading at 3 feet from surface of main container, provide reading at 1 foot from surface.

6. Extent of removable surface contamination. If none, cite "No removable surface contamination."

(2) Pickup point and destination of shipment, to include:

(*a*) Name, title, organization, and telephone number of individual at pickup point.

(*b*) Name, title, organization, and telephone number of individual at destination.

(*c*) Desired shipment date.

(*d*) Special requirements placed on shipment.

(3) Fund citation and authority to obligate funds in an amount sufficient for travel and other expenses incident to services required. The shipper must fund for technical escort service. Funding estimates, when required, can be obtained from USATEU.

CHAPTER 8
SECURITY OF SPECIAL NUCLEAR MATERIAL DURING TRANSIT

8-1. Purpose and Scope

This chapter describes the requirements for security (physical protection) of special nuclear material during transit. Requirements are for protection against industrial sabotage and theft by use of armed guards and escorts to deter attack, and by liaison and communication with law enforcement authorities capable of rendering assistance to counter such attacks (10 CFR 73.1).

8-2. Applicability (10 CFR 73.1)

The provisions of this chapter apply to shipments that meet the following requirements:

a. The shipment contains formula quantities of strategic special nuclear material, special nuclear material of moderate strategic significance, or special nuclear material of low strategic significance.

b. The shipment is by air and contains quantities exceeding:

(1) 20 grams or 20 curies, whichever is less, of plutonium or uranium-233, or

(2) 350 grams of uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope).

8-3. General Requirements (10 CFR 73.17 through 73.37)

a. Each consignor who transports, or who delivers to a carrier for transport, amounts of special nuclear material designated in paragraph 8-2 shall make arrangements to assure that such material will be transported under established procedures that provide a system for the physical protection of valuable materials in transit. This system shall require an exchange of hand-to-hand receipts at origin and destination and at all points en route where custody is transferred.

b. Except for shipments described in paragraph 8-2*b*, transit times shall be minimized and routes shall be so selected to avoid areas of natural disasters or civil disorder. These shipments will be preplanned to assure that deliveries at the final delivery point are made when the consignor is present to accept shipment.

c. Except for shipments described in paragraph 8-2*b*, special nuclear material subject to the requirements of this chapter shall be shipped in containers that are sealed by tamper-indicating-type seals. The container also shall be locked if it is not inside another container or vehicle that is locked. If State or local authorities are not required to inspect the container or vehicle before final destination, the outermost container or vehicle also shall be sealed by tamper-indicating-type seals. No container weighing 500 pounds or less shall be shipped in open trucks, railroad flatcars, boxcars, or ships.

d. A person will not be permitted to act as a guard unless documents show that the person has been qualified by proving an understanding of his duties and responsibilities. Guards shall be required to requalify annually.

e. Each licensee who takes delivery of special nuclear material free on board (f.o.b.), at which it is delivered to a carrier for transport, shall make arrangements to assure that such material will be protected in transit as prescribed in *a* through *d* above and in paragraphs 8-4 through 8-8. This removes such responsibility from the person who delivers such shipment to the carrier for transport.

f. Each licensee who imports special nuclear material shall make arrangements to assure that such material will be protected in transit as follows:

(1) A person designated by the licensee or his agent, or as specified by a contract of carriage, shall confirm the container count and examine locks and/or seals for evidence of tampering at the first place in the United States at which the shipment is discharged from the arriving carrier.

(2) The shipment shall be protected at the first terminal at which it arrives in the United States and at all subsequent terminals as provided in 10 CFR 73.25 through 73.37 and in *g* through *j* below.

g. Each licensee who delivers special nuclear material to a carrier for transport shall immediately notify the consignee, by telephone, telegraph, or teletype, of the departure time of the shipment, and shall notify or confirm with the consignee the transport method, including the names of carriers, and the estimated time of arrival (ETA) of the shipment at its destination.

(1) In the case of a shipment f.o.b., the point where it is delivered to a carrier for transport, each licensee shall, before the shipment is delivered to the carrier, obtain written certification from the licensee who is to take delivery of the shipment at the f.o.b. point that the physical protection arrangements required by 10 CFR 73.25 through 73.37 for licensed shipments have been made. When a contractor exempt from the requirements for an NRC license is the consignee of a shipment, the licensee shall, before the shipment is delivered to the carrier, obtain from the contractor who is to take delivery of the shipment at the f.o.b. point written certification that the physical protection arrangements required by DOE Manual, chapter 2401 or 2504, or 10 CFR as appropriate, have been made.

(2) Each licensee who delivers special nuclear material to a carrier for transport, or who releases special nuclear material f.o.b. at the point where it is delivered to a carrier for transport, shall also arrange with the consignee to be notified immediately, by telephone and telegraph or teletype, of the arrival of the shipment at its destination.

h. Besides complying with the requirements specified in *g* above and *j* below, each licensee who exports special nuclear material shall comply with the requirements specified in 10 CFR 73.25 through 73.37, as applicable, up to the first point outside of the United States where the shipment is taken off the vehicle. The licensee shall also arrange with the consignee to be notified immediately, by telephone and telegraph, teletype, or cable, of the arrival of the shipment at its destination or of any such shipment that is lost or unaccounted for after the estimated time of arrival (ETA) at its destination.

i. Each licensee who receives a shipment of special nuclear material shall immediately notify, by telephone and telegraph or mailgram, or by facsimile, the person who delivered the material to a carrier for transport and the director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in table 6-1 of the arrival of the shipment at its destination. When the consignee is a DOE license-exempt contractor, the licensee (the consignor) shall, immediately upon being notified by the consignee of the arrival of the shipment, notify the director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office (listed in table 6-1). This notification shall be by telephone and telegram, mailgram, or facsimile, as arranged pursuant to *g*(2) above. If such a shipment fails to arrive at its destination at the ETA, the consignee, if a licensee, or, in case of an export shipment, the licensee who exported the shipment shall immediately notify, by telephone and telegraph, mailgram, or facsimile, the director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office (listed in table 6-1) and the licensee or other person who delivered the material to a carrier for transport. The licensee who made the physical protection arrangements shall also immediately notify, by telephone and telegraph, or teletype, the director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office (listed in table 6-1) of the action being taken to trace the shipment.

j. Each licensee who arranges for physical protection of a shipment of special nuclear material, as required by 10 CFR 73.25 through 73.37, shall immediately conduct a tracer of any shipment that is lost or unaccounted for after the ETA and file a report with the commission, as specified in 10 CFR 73.71. If the licensee who conducts the tracer is not the consignee, he shall also immediately report the results of his investigation, by telephone and telegraph, or teletype, to the consignee.

8-4. Shipment by Highway (10 CFR 73.26)

a. All highway shipments shall be made without any scheduled intermediate stops to transfer special nuclear material or other cargo between the shipping and receiving facilities.

b. All motor vehicles used to transport special nuclear material shall be equipped with a radiotelephone that can communicate with a licensee or his agent. The licensee or agency with whom communications shall be maintained for different segments of the shipment shall be predesignated before a shipment. Calls to such licensee or agent shall be made at least every 2 hours when radiotelephone or conventional telephone coverage along the route is available, to relay position and projected route. Call frequency may extend up to 5 hours when radiotelephone or conventional telephone coverage is not available along the preplanned route, at which time a conventional telephone call shall be made. If no call is received according to these requirements, the licensee or his agency shall immediately notify an appropriate law enforcement authority and the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office (listed in table 6-1).

c. A shipment shall be accompanied by at least two people in the vehicle containing the shipment, who may be two drivers or one driver and an authorized person. The vehicle containing the shipment shall be under constant visual surveillance, or one of the drivers or authorized persons shall be in the cab

of the vehicle, awake, and not in a sleeper berth. The shipment shall be further protected by one of the following methods:

(1) An armed escort, consisting of at least two guards, shall accompany the shipment in a separate escort vehicle. Escorts shall maintain constant surveillance for conditions or situations that might threaten the security of the shipment and take such action as circumstances might require. Escort vehicles shall be equipped also with a radiotelephone. The licensee may use his employees as armed escorts or he may use an agent. Only the driver is required in the vehicle containing special nuclear material if shipments involve an average of less than an hour in transport, if communication is maintained during the shipment with the licensee or agent monitoring the shipment.

(2) The shipment shall be made in a specially designed truck or trailer, which reduces the vulnerability to diversion. Design features of the truck or trailer shall permit immobilization of the van and provide barriers or deterents to physical penetration of the cargo compartment unless armed guards are also used, in which case immobilization of the vehicle is not required.

d. Transfers to and from other transport modes shall be according to 10 CFR 73.25 and paragraph 8-8.

e. Vehicles shall be marked on top with identifying letters or numbers, which will permit identification of the vehicle from the air during daylight, in clear weather, at 1,000 feet above ground level. The same code of letters and numbers used on the top shall be marked also on the sides and rear of the vehicle, to permit identification from the ground.

8-5. Shipment by Air (10 CFR 73.26)

a. Except as specifically approved by the Nuclear Regulatory Commission, no shipment shall be made in passenger aircraft of special nuclear material in excess of:

(1) 20 grams or 20 curies, whichever is less, of plutonium or uranium-233, or

(2) 350 grams of uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope).

b. In shipments on cargo aircraft of uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium, or any combination of these materials which is 5,000 grams or more computed by the following formula: grams = (grams contained U-235) + 2.5 (grams U-233 + grams plutonium), transfers shall be minimized and according to 10 CFR 73.25 and paragraph 8-8.

c. Export shipments shall be escorted by an unarmed authorized person, who may be a crew member, from the last terminal in the United States until the shipment is unloaded at a foreign terminal. The escort shall perform monitoring duties at foreign terminals as described in 10 CFR 73.25 and paragraph 8-8.

8-6. Shipment by Rail (10 CFR 73.26)

a. A rail shipment shall be escorted by two guards, in the shipment car or in an escort car of the train, who shall keep the shipment cars under observation and who shall detrain at stops, when practicable and time permits, to guard the shipment cars and to check car or container locks and seals. Radiotelephone communication shall be maintained with a licensee or his agent to relay position every 2 hours or less and at scheduled stops, if radiotelephone coverage was not available in the last 5 hours before the stop. The licensee or agent with whom communications shall be maintained for different segments of the shipment shall be predesignated before a shipment. If no call is received according to these requirements, the licensee or his agency shall immediately notify an appropriate law enforcement authority and the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in table 6-1.

b. Transfers shall be according to 10 CFR 73.25 and paragraph 8-8.

8-7. Shipment by Sea (10 CFR 73.26)

a. Shipments shall be made on vessels making the least number of port calls. Transfer to and from other transport modes shall be according to 10 CFR 73.25 and paragraph 8-8. There shall be no scheduled transfers to other ships unless permission to do so has been granted by the Secretary of the Navy or his authorized representatives. At domestic ports of call where other cargo is transferred, the shipments shall be protected according to 10 CFR 73.25.

b. The shipment shall be placed in a secure compartment, locked, and sealed. Locks and seals shall be inspected periodically in transit, if accessible, by an escort or crew member.

c. Export shipments shall be escorted by an unarmed authorized person, who shall be furnished by the shipper, from the last port in the United States until the shipment is unloaded at a foreign port. The escort shall perform monitoring duties at foreign ports as described in 10 CFR 73.25 and paragraph 8-8.

d. Ship-to-shore communications shall be available, and a ship-to-shore contact shall be made every 24 hours to relay position and shipment status, which

shall be determined by a daily inspection where possible. This information shall be sent, as often as it is available, to the licensee or his agent who arranged for the protection of the shipment.

8-8. Transfer of Special Nuclear Material (10 CFR 73.25)

All transfers shall be monitored by a guard. An alternate guard shall be designated at all transfer points to substitute, if necessary. Monitoring of special nuclear material transfers shall be conducted as follows:

a. At scheduled intermediate stops where special nuclear material is not scheduled for transfer, the guard shall observe the opening of the cargo compartment and assure that the shipment is not removed. The guard shall maintain constant visual surveillance of the cargo compartment until the vehicle has departed and shall notify the licensee or his agent of the latest status immediately thereafter.

b. At points where special nuclear material is transferred from vehicle to storage, from vehicle to vehicle, or from storage to vehicle, the guard shall keep the shipment under constant visual surveillance by observing the opening of the cargo compartment of the incoming vehicle and by checking locks and/or seals to assure that the shipment is complete. Constant visual surveillance of a shipment shall be maintained at all time while in the terminal or in storage. Shipments shall be preplanned to avoid storage times in excess of 24 hours. Constant visual surveillance of the cargo compartment shall be maintained until the vehicle is ready to depart the terminal. The guard shall observe the vehicle until it has departed and shall notify the licensee or his agency of the latest status immediately thereafter.

c. The guard shall be required to immediately notify the carrier and the licensee who arranged for protection of special nuclear material of any deviation from or attempted interference with schedule or routing.

CHAPTER 9
QUALITY ASSURANCE

Section I. GENERAL

9-1. Need for a Quality Assurance Program

US Nuclear Regulatory Commission (NRC) regulations require a quality assurance program to be applied to the design, fabrication, assembly, testing, maintenance, repair, modification, and use of packaging to be used for transporting radioactive materials (10 CFR 71.37). The quality assurance program must satisfy each of the applicable criteria specified in 10 CFR 71.101, Appendix H, "Quality Assurance Criteria for Shipping Packages for Radioactive Material" (10 CFR 71.37).

9-2. Purpose and Scope

This chapter outlines the quality assurance program requirements for shippers of radioactive materials to ensure that packaging used will perform satisfactorily in service.

9-3. Quality Assurance Program Defined

As used in this manual, quality assurance comprises all of those planned and systematic actions required to assure that a system or component will perform satisfactorily in service. Quality assurance includes quality control assurance actions related to control of the physical characteristics and quality of materials or components to meet predetermined requirements.

Section II. QUALITY ASSURANCE PROGRAM REQUIREMENTS (10 CFR 71.101, APPENDIX H)

9-4. Quality Assurance Program

a. The authority and duties of persons and organizations performing activities affecting the safety-related functions of structures, systems, and components shall be clearly established and delineated in writing for both active and quality assurance functions. The quality assurance functions are:

(1) Assuring that an appropriate quality assurance program is established and effectively executed.

(2) Verifying, by such means as checking, auditing, and inspecting to ascertain that the activities affecting the safety-related functions have been correctly performed.

b. The persons and organizations performing quality assurance functions shall have enough authority and organizational freedom to:

(1) Identify quality problems.

(2) Initiate, recommend, or provide solutions.

(3) Verify implementation of solutions.

c. Quality assurance organizations shall report to a sufficiently high management level that the required authority and organizational freedom is achieved. This includes providing adequate independence from cost and schedule when confronting with safety considerations.

9-5. Basic Elements of the Quality Assurance Program

a. The quality assurance program shall be documented by written procedures or instructions and shall be carried out according to those instructions.

b. The quality assurance program shall provide control over activities affecting the quality of the identified materials and components to an extent consistent with their importance to safety and, as necessary, to assure conformance to the approved design of each individual package used for shipping of radioactive materials. Activities affecting quality shall be accomplished under suitably controlled conditions, to include:

(1) Use of appropriate equipment.

(2) Establishment of suitable environmental conditions, such as adequate cleanliness.

(3) Assurance that all prerequisites for a given activity have been satisfied.

(4) Taking into account the need for special control processes, test equipment, tools, and skills.

(5) Verification of quality by inspections and tests.

c. Requirements and procedures of the quality assurance program shall be based on the following considerations concerning the complexity and proposed use of the package and its components:

(1) The importance of a malfunction or failure of the item regarding safety.

(2) The design and fabrication complexity of uniqueness of the item.

(3) The need for special controls over and surveillance of processes and equipment.

(4) The degree to which functional compliance can be demonstrated by inspection or test.

(5) The quality history and degree of standardization of the item.

d. The quality assurance program shall provide for indoctrination and training of personnel performing activities affecting quality. Required training shall be that necessary to ensure that suitable proficiency is achieved and maintained.

9-6. Design Control Measures

a. Measures shall be established to assure that applicable regulatory requirements and the package design are correctly translated into specifications, drawings, procedures, and instructions. These measures include provisions to assure that the appropriate quality standards are included in design documents.

b. Design interface measures shall be established to include written procedures among participating organizations for the review, approval, release, distribution, and revision of documents involving design interfaces.

c. Design control measures shall be established to verify or check the adequacy of design. These measures include:

(1) Design reviews.

(2) Alternate or simplified calculation methods.

(3) A suitable testing program.

The verifying or checking process shall be performed by persons or groups other than those who initiated the original design, although they may be from the same organization.

d. Design control measures shall be applied to items in such areas as:

(1) Criticality physics.

(2) Radiation shielding.

(3) Stress analysis.

(4) Thermal analysis.

(5) Hydraulic analysis.

(6) Accident analysis.

(7) Compatibility of materials.

(8) Accessibility of inservice inspection, maintenance, and repair.

(9) Features to facilitate decontamination.

(10) Delineation of acceptance criteria for inspections and tests.

9-7. Procurement and Control of Materials, Parts, and Components

a. Measures shall be established to assure that applicable requirements, which are necessary to assure adequate quality, are suitably included or referenced in the documents for materials, equipment, and services. These measures will assure that these items, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. To the extent necessary, contractors or subcontractors shall be required to provide and document a quality assurance program consistent with that in 10 CFR 71.

b. Measures shall be established for identifying and controlling materials, parts, and components. These measures shall assure that identification of the item is maintained by NSN number, part number, or other appropriate means, either on the item or on records traceable to the item. These measures shall be designed to prevent the use of incorrect or defective materials, parts, and components.

9-8. Records Documentation and Document Control

a. The quality assurance shall include maintaining, during the life of the packaging to which they pertain, adequate quality assurance records to furnish documentary evidence of:

(1) Quality of packaging components that have safety significance.

(2) Services affecting the quality of packaging components.

(3) Monitoring, inspecting, and auditing work performed during design, fabrication, assembly, testing, modification, maintenance, repair, and use of the packaging.

b. Quality assurance record shall include closely related data such as:

(1) Qualifications of personnel, procedure, and equipment.

(2) Inspection and test records, to include, as a minimum, the identity of the inspector or data recorder, type of observation, results, and actions taken concerning deficiencies noted.

c. Quality assurance records shall be identifiable and retrievable.

d. Measures shall be established to control the issuance of documents, such as instructions, procedures, and drawings, including changes, that prescribe all activities affecting quality.

(1) Activities affecting quality shall be prescribed by documentation of a type appropriate to the circumstances and shall be accomplished according to these procedures, instructions, or drawings. This documentation shall include appropriate qualitative or quantitative acceptance criteria for determining that important activities have been satisfactorily accomplished.

(2) Document control measures shall assure that documents, including changes, are reviewed for adequacy and approved for release by authorized personnel. Changes to documents shall be reviewed and approved by the same organization(s) that performed the original review and approval.

(3) Document control measures shall assure that documents are distributed and used where the prescribed activity is performed.

9-9. Inspections and Tests

a. A program for inspection of activities affecting quality shall be established and executed by or for the organization performing the activity.

(1) The inspection shall be performed by person(s) who did not perform the activities being inspected.

(2) Examination, measurements, or tests of material or products shall be performed for each work operation, where necessary, to assure quality.

(3) If inspection of processed material or products is impossible or impractical, indirect control by monitoring processing methods, equipment, and personnel shall be provided.

(4) If required to assure adequate quality, both measurement/tests of products and process monitoring shall be provided.

(5) If mandatory inspection hold points (points beyond which work should not proceed until previous work has been inspected and approved) are required, they shall be indicated in appropriate documents.

b. A test program shall be established to assure that the packaging/components perform satisfactorily.

(1) Written test procedures will include requirements and acceptance limits contained in applicable packaging approvals.

(2) Procedures shall contain provisions for assuring that all prerequisites for the given test have been met.

(3) Procedures shall contain provisions to assure that adequate test instrumentation is available and is used and that the test is performed under suitable environmental conditions.

c. Control measures shall be established to assure that tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified items, to maintain accuracy within necessary limits.

d. Measures shall be established to indicate, by use of markings such as stamps, tags, labels, routing cards, or other suitable means:

(1) The status of inspections and tests performed on separate items of the packaging.

(2) The operating status of components of the packaging, such as tagging valves and switches, to prevent inadvertent operation.

e. Measures shall be established to assure that conditions adverse to quality, such as deficiencies, deviations, defective material and equipment, and nonconformances, are promptly identified and corrected.

(1) In cases of significant condition(s) adverse to quality, the measures shall assure that the cause of the condition is determined and that corrective action is taken to prevent repetition.

(2) The identification, cause, and corrective actions taken regarding significant condition(s) adverse to quality shall be documented and reported to appropriate levels of management.

(3) Nonconforming items shall be reviewed and accepted, rejected, repaired, or reworked according to documented procedures. Control measures must ensure that nonconforming items are not inadvertently used or installed.

9-10. Special Processes, Handling, Storage, and Shipping

a. Measures shall be established to assure that special processes, including welding, heat treating, and nondestructive testing, are controlled and accomplished by qualified personnel using qualified procedures according to all package requirements.

b. Handling, storage, shipping, cleaning, and preservation of materials and equipment to be used in packaging shall be controlled to prevent damage or deterioration. When necessary, special protective environments shall be specified and provided.

9-11. Quality Assurance Audits

A comprehensive system of planned and periodic audits shall be carried out to verify compliance with all aspects of the program and to determine the effectiveness of the program.

a. The audits shall be performed according to written procedures or checklists.

b. The audits shall be performed by appropriately trained personnel not directly responsible for the areas being audited.

c. Audit results shall be documented and reviewed by management responsible for the area audited. Followup action, to include reaudit of deficient areas, shall be taken where indicated.

CHAPTER 10
AIR MOVEMENT

Section I. GENERAL

10-1. Purpose and Scope

This chapter outlines specific regulatory and procedural requirements that apply to air movement of radioactive materials. It addresses shipments by both commercial and military aircraft.

10-2. Organization and Use

Section II contains regulatory and procedural requirements not listed elsewhere in this manual, and section III contains user checklists referenced to air movement regulatory and procedural requirements described in this and other chapters in this manual.

Section II. REGULATORY AND PROCEDURAL REQUIREMENTS

10-3. Aircraft Quantity Limitations (49 CFR 175.75)

a. The maximum quantity of hazardous material that may be offered for air transport in a package may not exceed that quantity prescribed for the material in 49 CFR 172.101. The total transport index of a group of packages may not exceed 50.

b. When offered for air transport, the combined quantity of any one class of materials may not exceed the lowest maximum quantity prescribed in 49 CFR 172.101 for any one material in that class contained in the same package.

10-4. Unacceptable Preparation for Shipment (49 CFR 175.3)

A shipment of radioactive materials that is not prepared for shipment according to 49 CFR 172 and 173 may not be accepted for transport or transported aboard an aircraft.

10-5. Accepting Shipments (49 CFR 175.30)

a. To be acceptable for air shipment, radioactive material must be described and certified on a shipping paper, prepared in duplicate, according to 49 CFR 172, subpart C (chap 5). The originating aircraft operation must retain one copy of each shipping paper for 90 days.

b. Radioactive materials accepted for air shipment must be labeled, marked, and placarded as provided in 49 CFR 172 (chap 5). A Cargo Aircraft Only label (49 CFR 172.448) must be affixed unless carriage on a passenger aircraft is permitted under *c* below.

c. For radioactive materials to be carried aboard a passenger aircraft, the shipment must be accompanied by a clear, visible statement, signed or stamped by the shipper or his agent as prescribed in 49 CFR 172.205, that the shipment contains radioactive materials for use in or incident to research or medical diagnosis or treatment and meets all applicable requirements for shipment in passenger-carrying aircraft.

d. No radioactive materials may be carried aboard an aircraft until the aircraft operator has inspected the package or outside container and has determined that the package has no holes, leakage, or other indication that its integrity has been compromised, and that the package seal has not been broken.

10-6. Notification of Pilot-in-Command (49 CFR 175.33)

When radioactive materials are carried in an aircraft, the aircraft operator shall give the pilot-in-command the following information, in writing, before takeoff:

a. The information required by 49 CFR 172.202 and 172.203 (para 5-18).

b. The location of the radioactive material in the aircraft.

c. The results of the inspection required in paragraph 10-5*d*.

10-7. Shipping Papers Aboard Aircraft (49 CFR 175.35)

a. A copy of the shipping papers required (para 10-5*a*) must accompany the shipment described thereon during transport aboard an aircraft.

b. The documents required by *a* above and paragraph 10-6 may be combined into one document if this document is given to the pilot-in-command before departure of the aircraft.

10-8. Accident/Incident Reporting (49 CFR 175.45)

General reporting requirements for accidents/incidents involving hazardous materials are contained in chapter 7. Additional requirements for air shipment are detailed below.

a. Each operator who transport radioactive materials shall report accidents or incidents to the nearest FAA Civil Aviation Security Office. This report shall be telephonic and shall be made at the earliest practicable time after each incident that occurs during transport by commercial aircraft (including loading, unloading, or temporary storage). Incidents/accidents governed by this provision are those in which, as a direct result of the radioactive material:

(1) A person is killed.

(2) A person received injuries requiring hospitalization.

(3) Estimated carrier or other property damage, or both, exceeds $50,000.

(4) Fire, breakage, spillage, or suspected radioactive contamination occurs.

(5) Such a situation exists that, in the judgment of the carrier, it should be reported, although it does not meet the criteria contained in (1), (2), or (3) above; for example, a continuing danger to life exists at the scene of the incident.

b. Reports required by *a* above shall contain the following information:

(1) Name of reporting person.

(2) Name and address of carrier represented by reporter.

(3) Phone number where reporter can be contacted.

(4) Date, time, and location of the incident.

(5) Extent of injuries, if any.

(6) Classification, name, and quantity of hazardous material involved, and whether a continuing danger to life exists at the scene.

c. Each operator who transports hazardous materials shall report in writing, in duplicate, on DOT Form F5800.1 within 15 days of the date of discovery, each incident that occurs during transport (including loading, unloading, or temporary storage). For this report, incidents are those governed by *a* above, or in which there has been an unintentional release of hazardous material from any package. Each operator making this report shall send it to the Office of Hazardous Materials Transportation, Department of Transportation, Washington, DC 20590, commercial (202) 366-0656, with a separate copy to the FAA facility indicated in *a* above.

(1) As required in chapter 7 and in addition to the reports required above, the carrier must notify the shipper at the earliest practicable moment following any incident in which there has been a breakage, spillage, or suspected radioactive contamination involving radioactive materials shipment.

(2) Aircraft in which radioactive materials have been spilled may not be returned to service or routinely occupied until the radiation dose rate at any accessible surface is less than 0.5 millirem per hour and there is no significant radioactive surface contamination (para 3-9).

(3) In accident/incident situations, the package or materials should be segregated, as far as practicable, from personnel contact. Radiological assistance (if required) should be obtained from the US Department of Energy, as indicated in chapter 7. In case of obvious leakage, or if it appears likely that the inside container may have been damaged, care should be taken to avoid inhalation of, ingestion of, or contact with the radioactive materials. Any loose radioactive materials should be left in a segregated area pending disposal instructions from qualified persons.

10-9. Cargo Location (49 CFR 175.85 and 175.700)

a. Except as provided in paragraph 10-14, radioactive materials may not be carried aboard passenger-carrying aircraft after 2 May 1989. Radioactive materials will not be transported in the cabin of a passenger-carrying aircraft.

b. Radioactive materials acceptable only for cargo-only aircraft must be carried in a location accessible to a crew member during flight. However, when carried on a small, single-pilot, cargo-only aircraft being used when other transport means are impracticable or unavailable, they may be carried, subject to quantity limits indicated in paragraph 10-3, in a location that is not accessible to the pilot, provided that:

(1) No person other than the pilot, an FAA inspector, the shipper or consignee (or a representative of the shipper or consignee, designated as such in writing), or a person necessary for handling the material may be carried aboard the aircraft.

(2) The pilot must be given written instructions on the characteristics and proper handling of the material.

(3) When a change of pilots occurs while the material is onboard, the new pilot must be briefed under a hand-to-hand signature service provided by the aircraft operator.

c. Radioactive materials carried in an aircraft must be suitably safeguarded to prevent their becom-

ing a hazard by shifting. Packages labeled Radioactive Yellow-II or Radioactive Yellow-III must be restrained to prevent movement that would permit the package to shift closer than specified in paragraph 10-10 to a space occupied by a person or an animal.

d. No person may place any package of radioactive materials labeled Radioactive Yellow-II or Radioactive Yellow-III in an aircraft closer than the distances shown in table 10-1 to a space (or dividing partition between spaces) that may be occupied by packages of undeveloped film (if so marked). If more than one package of radioactive materials is present, the total transport index (sum of individual transport indexes) will be used as a basis for table 10-1.

10-10. Separation Distance Requirements for Packages Containing Radioactive Materials in Passenger-Carrying Aircraft

a. General. No person may carry in a passenger-carrying aircraft any package labeled Radioactive Yellow-II or Radioactive Yellow-III unless the package is placed in the aircraft according to the minimum separation distances prescribed in *b* or *c* below.

b. Separation Distances.

(1) Except as provided in *c* below, the minimum separation distances prescribed in (2) below are determined by measuring the shortest distance between the surfaces of the radioactive materials package and the surfaces bounding the space occupied by passengers or animals. If more than one package of radioactive materials is placed in a passenger-carrying aircraft, these packages shall be determined according to (2) below based on the total transport index for the individual packages or overpacks.

(2) Table 10-1 prescribes minimum separation distances for carrying packages labeled Radioactive Yellow-II or Radioactive Yellow-III in passenger-carrying aircraft.

c. Predesignated Areas. A package labeled Radioactive Yellow-II or Radioactive Yellow-III may be carried in a passenger-carrying aircraft according to a system of predesignated areas established by the aircraft operator. Each aircraft operator who elects to use a system of predesignated areas shall submit a detailed description of the proposed system to the Director, Office of Hazardous Materials Transportation (OHMT) for approval before implementing the system. A proposed system of predesignated areas is approved if the Director, OHMT determines that it is designed to assure that:

(1) The packages can be placed in each predesignated area according to the minimum separation distances prescribed in *b*(2) above, and

(2) The predesignated areas are separated from each other by minimum distance equal to at least four times the distances required by *b*(1) and (2) above for the predesignated area containing packages with the largest sum of transport indexes.

10-11. Special Requirements for Fissile Class III Radioactive Materials (49 CFR 175.703(c))

No person may carry aboard any aircraft any package of Fissile Class III radioactive material (para 2-17) except as follows:

a. On a cargo-only aircraft that has been assigned for the sole use of the consignor for the specific shipment of fissile radioactive material. Instructions for such sole use must be provided for in special arrangements between the consignor and the carrier, with instructions to that effect issued with the shipping papers, or

b. On any aircraft that contains no other packages of radioactive labels described in chapter 5. Specific arrangements must be effected between the shipper and carriers, with instructions to that effect issued with the shipping papers, or

Table 10-1. Separation Distance Requirements

Transport index	Minimum separation distance to nearest undeveloped film for various times of transit									
	Up to 2 hours		2 to 4 hours		4 to 8 hours		8 to 12 hours		Over 12 hours	
	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet
0.1 to 1.0	0.3	1	0.6	2	0.9	3	1.2	4	1.5	5
1.1 to 5.0	0.9	3	1.2	4	1.8	6	2.4	8	3.3	11
5.1 to 10.0	1.2	4	1.8	6	2.7	9	3.3	11	4.5	15
10.1 to 20.0	1.5	5	2.4	8	3.6	12	4.8	16	6.6	22
20.1 to 30.0	2.1	7	3.0	10	4.5	15	6.0	20	8.7	29
30.1 to 40.0	2.4	8	3.3	11	5.1	17	6.6	22	9.9	33
40.1 to 50.0	2.7	9	3.6	12	5.7	19	7.2	24	10.8	36

NOTE: The distance in the table must be measured from the nearest point on the packages of radioactive materials.

c. According to any other procedure specifically approved by the Director, OHMT, Materials Transportation Bureau.

10-12. Special Requirements and Restrictions (49 CFR 175.703)

a. No person may carry in an aircraft any package of radioactive material labeled Radioactive Yellow-II or Radioactive Yellow-III, required by chapter 5 of this manual, closer than the distances shown in table 10-1 to any package marked as containing undeveloped film.

b. No person may accept for carriage in an aircraft packages of radioactive materials, other than limited quantities, contained in a rigid or nonrigid overpack, including a fiberboard box or plastic bag, unless the packages have been prepared for shipment according to the general transport requirements specified in 49 CFR 173.448.

c. No person may offer or accept for transport, nor transport, by air:

(1) Any Type B(U) or B(M) package with an accessible surface temperature in excess of 50°C (122°F);

(2) Continuously vented Type B(M) packages, packages that must be cooled by an auxiliary cooling system, or packages subject to operational controls during transport; or

(3) Liquid pyrophoric radioactive materials.

d. Packages with radiation levels that exceed 200 millirems per hour at any point on the external surface of the package, or a transport index in excess of 10, may not be transported by aircraft except under special arrangements approved by the Research and Special Programs Administration, Department of Transportation.

10-13. Shipment by Military Aircraft

The special provisions of TM 38-250 (AFR 71-4) that apply to shipment of radioactive materials by military aircraft are outlined in *a* through *c* below; otherwise applicable Federal regulations must be complied with.

a. Radioactive Material Classification. For shipment by military aircraft, radioactive material is classed as a single-dagger (†) (TM 38-250) item. Such items will not be transported on passenger-carrying military aircraft.

b. Special Requirements.

(1) The local transportation officer will arrange for technically qualified personnel to advise the pilot before or during loading regarding the nature of and hazards associated with the shipment, proper handling procedures, and emergency in-flight procedures.

(2) Radioactive material shipments will be marked and labeled as prescribed by DOT regulations. DD Form 1387-2 (Special Handling Data/Certification) with attached shipper's certificate will be affixed to each package in the shipment. The certificate should read as follows:

> This is to certify that the contents of the packages in this shipment are properly described by name and are packed, marked, and in proper conditions for transport according to TM 38-250.

(3) A separate shipping document will be prepared for radioactive materials when general cargo is transported on the same aircraft. The shipping document will contain the proper shipping name (TM 38-250, table 5-1) and the above shipper's certification.

c. Movement by Military Airlift Command (MAC). Request for aircraft to move the materials covered by this manual will be processed and submitted according to AR 59-8 or AR 59-9.

10-14. Shipment by Passenger-Carrying Aircraft (49 CFR 175.700)

a. After 2 May 1989, a package containing a radioactive material may not be offered for transport aboard a passenger-carrying aircraft unless that material is intended for use in, or incident to, research, medical diagnosis, or treatment (49 CFR 173.4(b)).

b. Type B(M) packages may not be offered or accepted for transport, nor transported, on passenger-carrying aircraft.

c. No person may carry in a passenger-carrying aircraft any package labeled Radioactive Yellow-II or Radioactive Yellow-III, unless:

(1) For package labeled Radioactive Yellow-II, the transport index does not exceed 1.0;

(2) For package labeled Radioactive Yellow-III, the transport index does not exceed 3.0;

(3) The package is carried on the floor of the cargo compartment, or freight container; and

(4) The package is carried in the aircraft according to separation distance requirements specified in paragraph 10-10.

d. No person may carry in a passenger-carrying aircraft any Fissile Class III radioactive materials.

e. No person may carry in a passenger-carrying aircraft any package that exceeds the restrictions specified in paragraph 10-12.

10-15. Shipment by Cargo Aircraft Only (49 CFR 175.702)

a. As used in this section, the term "group of packages" means packages that are separated from each other in an aircraft by 20 feet (6 meters) or less.

b. No person may carry in a cargo aircraft only any package labeled Radioactive Yellow-II or Radioactive Yellow-III unless:

(1) The total transport index for all of the packages does not exceed 50.0 and the package is carried according to the separation distances specified in paragraph 10-10;

(2) The total transport index for all of the packages exceeds 50.0 and:

(*a*) The separation distance between the surfaces of the radioactive materials packages and the surfaces bounding the space occupied by persons or animals is at least 30 feet (9 meters);

(*b*) The transport index for any group of packages does not exceed 50.0;

(*c*) Each group of packages is separated from every other group in the aircraft by not less than 20 feet (6 meters), measured from the outer surface of each group; and

(*d*) The total transport index for all packages containing fissile radioactive materials does not exceed 50.0.

c. No package containing Fissile Class III radioactive material may be offered or accepted for transport by cargo aircraft except if the cargo aircraft contains no other packages that must be labeled radioactive as prescribed in chapter 5 of this manual. Specific arrangements must be made between the shipper and carrier, with instructions to that effect issued with the shipping papers (49 CFR 175.703(c)).

d. No package that exceeds the restrictions specified in paragraph 10-12 may be offered or accepted for shipment on cargo aircraft.

10-16. Shipment by Exclusive-Use Cargo Aircraft (49 CFR 175.703(c))

a. Fissile Class III radioactive materials may be offered or accepted for shipment in a cargo aircraft that has been assigned for the exclusive use of the shipper for the specific shipment of fissile radioactive material. Instructions for the exclusive use must be developed by the shipper and carrier and must be issued with the shipping papers.

b. No package that exceeds the restrictions specified in paragraph 10-12 may be offered or accepted for shipment on an exclusive-use cargo aircraft.

Section III. AIR MOVEMENT CHECKLIST

10-17. Use of Checklist

When a shipment of radioactive materials by air is planned or moved, the following checklist can be used as an aid to assure that all required actions or considerations are accomplished. The checklist consists of a series of questions, each requiring a yes answer. Necessary actions to allow a yes answer to each question should be accomplished to assure that a shipment meets the applicable criteria.

10-18. Air Movement Checklist

a. Have packaging checklists been completed? (4-25)

b. Has marking and labeling checklist been completed? (5-29)

c. Has placarding checklist been completed? (5-30)

d. Has documentation checklist been completed? (5-31)

e. Has general planning checklist been completed? (6-18*a*)

f. If applicable, has receiving and unloading checklist been completed? (6-18*b*)

g. Have appropriate parts of general shipping checklist been completed? (6-18*c*)

h. Are safety requirements met? (chap 7)

i. If applicable, are security requirements met? (chap 8)

j. Is the shipment within aircraft quantity limitations? (10-3)

k. Are requirements for accepting shipments met? (10-5)

l. Has the pilot-in-command been notified? (10-6)

m. Are appropriate shipping papers aboard the aircraft? (10-7)

n. Is cargo location proper? (10-9, 10-10)

o. If applicable, have special requirements for Fissile Class III shipments been met? (10-11)

p. If applicable, have all required accident/incident reports been completed? (10-8)

q. If applicable, have requirements for different types of airlift been met? (10-13 through 10-16)

CHAPTER 11
HIGHWAY MOVEMENT

Section I. GENERAL

11-1. Purpose and Scope

This chapter outlines specific regulatory and procedural requirements that apply to highway movement of radioactive materials. It addresses shipments by both commercial and military vehicles.

11-2. Organization and Use

Section II contains regulatory and procedural requirements not listed elsewhere in this manual. Section III contains user checklists referenced to highway movement regulatory and procedural requirements contained in this and other chapters of this manual.

Section II. REGULATORY AND PROCEDURAL REQUIREMENTS

11-3. Exempt Shipments

Highway shipments made under the exemption provisions of paragraphs 4-20 and 4-21 are exempt from 49 CFR 177 except for 49 CFR 177.817, *Shipping Papers* (chap 5).

11-4. Motor Carrier Safety Regulations

Every common carrier, contract carrier, and private carrier of property, as defined in part II, Interstate Commerce Act, engaged in interstate or foreign commerce, must comply with the provisions of 49 CFR 390 to 397, which comprise the motor carrier safety regulations. The provisions that are of particular importance to shippers include 49 CFR 393, "Parts and Accessories Necessary for Safe Operations" and 49 CFR 397, "Transportation of Hazardous Materials; Driving and Parking Rules." The latter part includes mandatory driving rules that apply to motor vehicles transporting any quantity of radioactive material that must be labeled. An outline of the driving rules is shown below:

a. Such motor vehicles will not be left unattended upon a public street or highway.

b. Such motor vehicles will be driven so as to avoid, so far as practicable and where feasible, congested thoroughfares, streetcar tracks, tunnels, viaducts, and dangerous crossings.

c. Refueling must be reduced to a minimum. If refueling is necessary, the electric ignition must be turned off and engine stopped. If the vehicle is equipped with a magneto, it shall be grounded.

d. Such motor vehicles will not be driven past any fires burning on or near the highway until due caution has been taken to make sure that such passing can be made safely.

e. Parking in congested places must be avoided.

f. Drivers of such motor vehicles may carry only safety matches.

g. The ITO is responsible to validate that carriers provided on route orders are in full compliance with 49 CFR 177.825.

11-5. Inspection Requirements for Commercial Vehicles

Before being loaded with any quantity of radioactive materials, each such motor vehicle must be inspected for compliance with 49 CFR 393. DD Form 626 (Motor Vehicle Inspection (Transporting Hazardous Material)) will be used for this purpose. *Only vehicles that have no unsatisfactory conditions will be accepted for loading.* The requirement for preparing DD Form 626 (Motor Vehicle Inspection) is contained in paragraph 33-19, AR 55-355. Further, to assure compliance with 49 CFR 397, the driver of each such motor vehicle will be furnished with a properly executed DD Form 836 (Special Instructions for Motor Vehicle Drivers).

11-6. Package Separation Requirements (49 CFR 177.842)

a. The number of packages of radioactive materials in any motor vehicle, trailer, or storage location must be limited so that the total transport index, the sum of the transport indexes (para 2-46) for the individual packages, does not exceed 50. This provision does not apply to exclusive-use shipments.

b. Packages of radioactive material labeled Radioactive Yellow-II or Radioactive Yellow-III must not be placed in cars, motor vehicles, trailers, or other places closer than the distances shown in table 11-1 to an area or a dividing partition between areas that may be continuously occupied by passengers, employees, or shipments of animals, nor closer than the distances shown to any package containing undeveloped film (if so marked). If more than one of these packages is present, the distance shall be computed based on the total transport index (the sum of the transport indexes on the individual packages (49 CFR 177.842)).

11-7. General Highway Requirements (49 CFR 177.807, 177.810, 177-811, 177.817, 177.825, and 177.842)

a. Carriers shall report incidents involving hazardous materials to the Department of Transportation as required by 49 CFR 171.15 and 171.16.

b. Carriers shall be required to comply with regulations established and published under authority of State statutes or municipal ordinances regarding the shipment of hazardous materials through any urban vehicular tunnel used for mass transport.

c. Any carrier possessing an astray shipment of radioactive material shall:

(1) Inspect the package to ensure that it is in proper condition for transport.

(2) Forward it promptly to its destination, if known.

d. Motor carriers may not transport radioactive materials unless they are accompanied by shipping papers prepared according to 49 CFR 172.201 through 172.204 (chap 5).

e. A driver of a motor vehicle containing radioactive material, and each carrier using such a vehicle, shall ensure that the required shipping papers are readily available to, and recognizable by, authorities in case of accident or inspection. Specifically, the driver and carrier shall:

(1) Clearly distinguish the shipping papers, if the radioactive material is carried with shipping papers or other papers of any kind, by either distinctly tabbing them or having them appear first. They shall be stored so that, when the driver is at the vehicle's controls, the shipping papers are within his reach while he is restrained by the lap belt. The papers must be readily visible to a person entering the driver's compartment or in a holder mounted inside the door on the driver's side of the vehicle.

f. Persons should not remain unnecessarily inside a vehicle containing radioactive materials.

11-8. Loading and Unloading Requirements (49 CFR 177.834)

a. Any package or container not permanently attached to a motor vehicle that contains radioactive material must be secured against movement within the vehicle on which it is being transported. This restraint must be sufficient for normal transport conditions.

b. No hazardous material shall be loaded into or on, or unloaded from, any motor vehicle unless the handbrake is securely set and all other reasonable precautions have been taken to prevent motion of the vehicle during loading or unloading.

11-9. Shipments of Fissile Materials (49 CFR 177.842(f))

a. Each Fissile Class III shipment (para 2-17) must be transported according to one of the methods in 49 CFR 173.457 (para 6-16). The transport controls must be adequate to assure that no Fissile Class III ship-

Table 11-1. Separation Distances for Radioactive Materials in Motor Vehicles

Total Transport index	Minimum separation distances, in feet, to nearest undeveloped film for various time of transit					Minimum distance, in feet, to area of persons, or from dividing partition of cargo compartments
	Up to 2 hours	2 to 4 hours	4 to 8 hours	8 to 12 hours	Over 12 hours	
None	0	0	0	0	0	0
0.1 to 1.0	1	2	3	4	5	1
1.1 to 5.0	3	4	6	8	11	2
5.1 to 10.0	4	6	9	11	15	3
10.1 to 20.0	5	8	12	16	22	4
20.1 to 30.0	7	10	15	20	29	5
30.1 to 40.0	8	11	17	22	33	6
40.1 to 50.0	9	12	19	24	36	7

NOTE: The distance in the table must be measured from the nearest point on the packages of radioactive materials.

ment is transported in the same vehicle with any other fissile radioactive material shipment.

b. In loading and storage areas, each Fissile Class III shipment must be segregated by at least 20 feet from other packages that must bear one of the radioactive labels described in chapter 5.

11-10. Contamination of Vehicles (49 CFR 177.843, paras 3-9 and 3-10)

a. Motor vehicles used for transporting low specific activity (LSA) radioactive materials in truckload lots must be surveyed, with appropriate radiation detection equipment, after each use. Vehicles must not be returned to service until the radiation dose rate is not more than 0.5 millirem per hour at any accessible surface and there is no significant removable radioactive surface contamination (paras 3-9 and 3-10).

b. The requirements of *a* above do not apply to any vehicle used solely for transporting radioactive material if a survey of the interior surface shows that the radiation dose rate does not exceed 10 millirems per hour on the interior surface or 2 millirems per hour at 3 feet from any interior surface. These vehicles must be stenciled with the words *FOR RADIOACTIVE MATERIALS USE ONLY* in lettering at least 3 inches high. This stenciled lettering must be in a conspicuous place, on both sides of the exterior of the vehicle. The vehicle must be kept closed at all times other than loading and unloading.

11-11. Movement by Military Vehicle (AR 385-11)

a. Radioactive materials will be loaded into a vehicle in such a way that the closest distance between the package and the driver, or any passenger in the cab of the vehicle, will not be less than the distances shown in table 11-1 for the conditions set forth. However, if a survey determines that the radiation in the cab will be less than 2 millirems per hour, and, based on a consideration of time en route, personnel will not receive more than 100 millirems in any 7 consecutive days or 0.5 rem in any calendar year.

b. Radioactive materials not packaged and labeled for offsite shipment may be moved locally within an installation, by unit transport, under the supervision of qualified installation personnel. If such moves involve the use of public highways that fall within the boundaries of an installation, the local transportation officer will obtain permission for the move from appropriate civil authorities. All appropriate safeguards and precautions for the protection of personnel and property within the installation will be taken.

c. All highway vehicles used for radioactive materials shipments will be thoroughly inspected before loading and must conform to the provisions listed on DD Form 626 (Motor Vehicle Inspection). This inspection will include a check of the number and type of fire extinguishers and a certification by the operator that they are in working condition.

d. Drivers of trucks moving escorted shipments of radioactive materials will be briefed carefully and furnished written instructions about the required safety and emergency procedures to ensure safe movement. Drivers will not park or service their vehicles in such a manner as to risk radiation exposure to occupants of other vehicles. Except while passing moving vehicles on the highway, drivers will maintain, and not decrease, a minimum safe distance between the escorted vehicles and all other vehicles. In case of an accident, the escort commander or driver will immediately establish a safe and suitable exclusion area around the shipment and prevent any unauthorized personnel or vehicle from entering this area. He will notify higher headquarters and ask for assistance, as needed, including local fire and police assistance. Any undue delay affecting the estimated time of arrival (ETA) will be reported to the consignor by the consignee, the driver, or the escort commander.

e. Vehicles transporting escorted shipments will operate at a safe speed conforming with local conditions, but will not exceed posted speed limits under normal operating conditions. During adverse weather or road conditions, the speed of the truck will be reduced to that safe for the existing conditions.

f. Shipments other than those requiring escort normally will require no Army restrictions other than those imposed by the appropriate regulatory bodies. Drivers of trucks hauling radioactive materials will be briefed on the shipment so that, in case of accident or fire, they can alert military or civilian authorities.

g. Escort commanders will also carry a copy of the written instructions containing emergency measures to be taken and telephone numbers of the installations to call for assistance.

11-12. Shipments on Motor Vehicles Carrying Passengers for Hire (49 CFR 177.870)

No person may transport any radioactive material labeled under 49 CFR 172.403 (para 5-6) in or on any motor vehicle carrying passengers for hire except when no other practicable means of shipment are available. Radioactive materials must be stored in the trunk or baggage compartment of the vehicle; they must not be stored in any compartment occupied by persons. Packages of radioactive materials

must be handled and placed in the vehicle as prescribed in paragraphs 11-6 and 11-8.

11-13. Accident Procedures (49 CFR 177.861)

Accident and incident procedures are contained in chapter 7. Vehicles, buildings, areas, or equipment in which radioactive materials have been spilled may not be returned to service or routinely occupied until the radiation dose rate at any accessible surface is less than 0.5 millirem per hour and there is no significant removable radioactive surface contamination (para 3-9).

Section III. HIGHWAY MOVEMENT CHECKLIST

11-14. Use of Checklist

When a shipment of radioactive materials by highway is planned or accomplished the following checklist can be used as an aid to assure that all required considerations are accomplished. The checklist consists of a series of questions, each requiring a yes answer. Necessary actions to allow a yes answer to each question should be accomplished to assure that a shipment meets the applicable criteria.

11-15. Highway Movement Checklist

a. Have packaging checklists been completed? (4-25)

b. Has marking and labeling checklist been completed? (5-29)

c. Has placarding checklist been completed? (5-30)

d. Has documentation checklist been completed? (5-31)

e. Has general planning checklist been completed? (6-18*a*)

f. If applicable, has receiving and unloading checklist been completed? (6-18*b*)

g. Have appropriate parts of general shipping checklist been completed? (6-18*c*)

h. Are safety requirements met? (chap 7)

i. If applicable, are security requirements met? (chap 8)

j. For exempt shipments, are all shipping paper requirements met? (11-3)

k. Are provisions adequate to assure that motor carrier safety regulations will be obeyed? (11-4)

l. Have required vehicle inspections been accomplished? (11-5)

m. Are package separation requirements met? (11-6)

n. Are special vehicle loading and unloading requirements met? (11-8)

o. For shipments of fissile materials, are special requirements met? (11-9)

p. Have proper contamination surveys been accomplished? (11-10)

q. For movement by military vehicle, have all special requirements been met? (11-11)

r. Are requirements for passenger-carrying vehicles satisfied? (11-12)

s. If applicable, have accident procedures been accomplished? (11-13)

CHAPTER 12
RAIL MOVEMENT

Section I. GENERAL

12-1. Purpose and Scope

This chapter outlines specific regulatory and procedural requirements that apply to the rail movement of radioactive materials. The requirements apply to both carrier-owned and Department of Defense-owned (DODX) railcars.

12-2. Organization and Use

Section II contains regulatory and procedural requirements for rail shipment not listed elsewhere in this manual. Section III contains user checklists referenced to railway movement regulatory and procedural requirements contained in this and other chapters of this manual.

Section II. REGULATORY AND PROCEDURAL REQUIREMENTS

12-3. Shipping Paper Requirements (49 CFR 174.24, 174.25, and 174.26)

a. Except as provided in *b* below, no person may accept for rail transport any radioactive material unless he has received shipping papers prepared according to paragraphs 5-18, 5-19, 5-23, and, when applicable, 5-20 and 5-21.

b. No crew member of a train transporting radioactive material is required to have the shipper's certificate, required by paragraph 5-19, on the shipping paper in his possession if the original shipping paper containing the certificate is in the originating carrier's possession. At least one member of the train crew must have copies of all remaining shipping papers indicated in *a* above.

c. Each waybill, switching ticket, switching order, or other billing prepared by the carrier from bills of lading or other shipping papers, as well as each shipping order used as a waybill for a railcar required to be placarded (paras 5-13 and 5-17), must, in addition to requirements of *a* above, be plainly marked with:

(1) If a flatcar is carrying trailers or containers, an indication of which trailers or containers contain the radioactive materials.

(2) The words RADIOACTIVE MATERIAL in letters not less than 3/8-inch high or in bold uppercase letters not less than 1/10-inch high inside a rectangle made with asterisks (*) or the number symbol (#). The notation will be near the space on the face of the billing that is provided for the car number. This provision applies only to material requiring a Radioactive Yellow-III label.

d. The train crew must have a document showing the position, in the train, of each loaded placarded car containing hazardous materials, except when the position is changed or added to the train by a crewmember on duty. A train consist may be used to meet this requirement.

e. Car(s) for personnel escorting shipments will be so positioned in the train as to follow immediately the car containing the shipment, except that in no case will the occupied portion of the escort car be positioned in such a manner that a container of radioactive material is closer than that specified in table 12-1.

12-4 Inspection of Certified Railcars

When certified railcars are used, they must be inspected inside and outside by both carrier and shipper, and they must conform to specifications described in 49 CFR 173 and 174. Prescribed car certificates must be completed in triplicate and disposed of according to the provisions of the same regulation. The transportation officer at the originating station will request the carrier to make a preloading inspection of the car before placing it for loading. This request will be made *before the loading date* to ensure availability of an acceptable car. The objective of this inspection is to select a car(s) that meets minimum safety standards without delay en route. The transportation officer will record the results of the in-

best copy available

Table 12-1. Separation Distances for Radioactive Materials in Railcars

Total transport index	Minimum separation distance, in feet, to nearest undeveloped film	Minimum distance, in feet, to areas of persons, or from dividing partition of a combination car
None	0	0
0.1 to 10.0	15	3
10.1 to 20.0	22	4
20.1 to 30.0	29	5
30.1 to 40.0	33	6
40.1 to 50.0	36	7

NOTE: This distance in the table must be measured from the nearest point on the packages of radioactive materials.

spection, and this record will be included in the shipping document file for the movement. As a minimum, this inspection will cover, but will not be limited to, the following points to ensure, as far as possible, safe uninterrupted movement:

a. The running gear, including the journal boxes, side frames, bolsters, brake rigging, and center pins.

b. The draft gear, including the couplers, draft gear pocket, and draft gear pin.

c. Wheels on selected cars will be closely checked to minimize the possibility of wheel changes en route.

12-5. General Loading and Handling Requirements (49 CFR 174.55 and 174.700)

a. Packages of radioactive material must be loaded and securely blocked and braced to prevent them from changing position, falling to the floor, or sliding into each other when subjected to normal transport conditions. This requirement does not preclude the use of approved loading methods that are designed to permit limited movement of the load.

b. Each package of radioactive materials marked THIS SIDE UP or THIS END UP must be handled, loaded, blocked, and braced in the car to remain in the position the markings indicate.

c. A heavy package or container of radioactive materials may be trucked; rolled; or moved by skid, forklift, or other handling device. It may NOT be dropped from any truck, platform, or railcar. Planks for rolling trucks from platforms to cars must have beveled edges.

d. Persons should not remain unnecessarily in a car containing radioactive materials.

e. Containers of radioactive material weighing 15,000 pounds or more may be loaded onto flatcars. Gondola cars (drop-bottom cars not authorized) may be used for the following:

(1) Radioactive materials in containers weighing 5,000 pounds or more.

(2) Strong wooden boxes with inside containers of solid radioactive material, securely braced and cushioned.

(3) Radioactive material in concrete-filled metal drums, or in concrete vaults weighing 700 pounds or more.

f. Shipments by rail must be properly loaded in closed cars, container cars, or in tight, closed truck bodies or trailers on flatcars, except as otherwise indicated. Ends, sidewalls, or doors of truck bodies will not be relied upon to prevent shifting of heavy loads unless properly designed.

g. Radioactive materials may NOT be loaded, transported, or stored with class A explosives.

h. Rail carriers may require consignee to remove shipments of dangerous articles from *carrier's property* within 48 hours' notice of arrival; Saturdays, Sundays, and holidays excluded.

i. DOT regulations require that, after acceptance from shippers, carriers must forward shipments of explosives and other dangerous articles promptly and within 48 hours; Saturdays, Sundays, and holidays excluded. Astray packages must be forwarded to destination immediately on an "astray bill," provided a careful inspection shows the package to be in proper condition for safe transport.

j. A placarded railcar may not be transported in a passenger train. However, it may be transported in a mixed train, but only at such times and between such points that freight train service is not in operation. Such mixed train transport is subject to the following limitations:

(1) A car placarded RADIOACTIVE may not be transported next to an occupied caboose or a passenger car.

(2) When a car with labeled hazardous materials is moved in a mixed train and the car is not occupied by an employee of the carrier, placards must be applied as required by subpart F, 49 CFR 712.

k. In a moving or standing train, a car placarded RADIOACTIVE may not be placed next to another placard car loaded with non-radioactive material (other than one placarded COMBUSTIBLE), an engine, an occupied caboose, or a carload of undeveloped film. Cars placarded RADIOACTIVE may be placed next to each other.

12-6. Location of Packages in Railcars (49 CFR 174.700)

Packages of radioactive material labeled Radioactive Yellow-II or Radioactive Yellow-III must not be placed in railcars, depots, or other places closer than the distances shown in table 12-1 to an area or a dividing partition between areas that may be occupied constantly by passengers, employees, or shipments of animals, nor closer than the distances shown to any package containing undeveloped film (if so marked). If more than one of these packages is present, the distance shall be computed based on the total transport index (sum of individual transport indexes).

12-7. Cleanliness of Railcars After Use (49 CFR 174.715)

Each railcar or other transport vehicle used to transport radioactive materials as exclusive use must be surveyed, with appropriate radiation detection instruments, after each use. A vehicle may not be returned to service until the radiation dose rate at any accessible surface is 0.5 millirem per hour or less and there is no significant removable radioactive surface contamination (paras 3-9 and 3-10). This requirement does not apply to any railcar used solely for transporting radioactive materials if a survey of the interior surface of the car shows that the radiation dose rate does not exceed 10 millirems per hour at the interior surface, or 2 millirems per hour at 3 feet from any interior surface. Such a car must be stenciled with the words FOR RADIOACTIVE MATERIALS USE ONLY in lettering at least 3 inches high in a conspicuous place on both sides of the exterior of the car, and it must be kept closed at all times other than during loading and unloading.

12-8. Special Requirements for Fissile Materials (49 CFR 174.700)

a. Each Fissile Class III shipment (para 2-17) must be transported according to one of the methods prescribed in 49 CFR 173.457 (para 6-16). The transport controls must be adequate to assure that no Fissile Class III shipment is transported in the same railcar with any other fissile radioactive material shipment.

b. In loading and storage areas, each Fissile Class III shipment must be segregated by at least 20 feet from other packages requiring one of the radioactive labels.

12-9. Accidents/Incidents Involving Leakage (49 CFR 174.750)

a. Accident/incident reporting procedures are contained in chapter 7.

b. Besides the other reporting requirements, the carrier shall notify the shipper at the earliest practicable time following any incident in which there has been breakage, spillage, or suspected radioactive contamination involving radioactive materials shipments. Vehicles, buildings, areas, or equipment in which radioactive materials have been spilled may not be returned to service or routinely occupied until the radiation dose rate at any accessible surface is less than 0.5 millirem per hour and there is no significant removable radioactive surface contamination (paras 3-9 and 3-10).

c. Packages or materials involved in the accident/incident should be segregated as far as practicable from personnel. If radiological advice or assistance is needed, the Department of Energy should be notified (chap 7). In case of obvious leakage, or if it appears likely that an inside container may have been damaged, care should be taken to avoid inhalation of, ingestion of, or contact with the radioactive material. Any loose radioactive materials should be left in a segregated area and held pending disposal instructions from qualified persons.

d. Information involving the handling of radioactive materials in the event of a wreck can be found in Bureau of Explosives Pamphlets 1 and 2.

Section III. RAIL MOVEMENT CHECKLIST

12-10. Use of Checklist

When a shipment of radioactive materials by rail is planned or moved, the following checklist can be used as an aid to assure that all required considerations are completed. The checklist consists of a series of questions, each of which requires a yes answer. Necessary actions to allow a yes answer to each question should be carried out to assure that a shipment meets the applicable criteria.

12-11. Rail Movement Checklist

a. Have packaging checklists been completed? (4-25)

b. Has marking and labeling checklist been completed? (5-29)

c. Has placarding checklist been completed? (5-30)

d. Has documentation checklist been completed? (5-31)

e. Has general planning checklist been completed? (6-18*a*)

f. If applicable, has receiving and unloading checklist been completed? (6-18*b*)

g. Have appropriate parts of general shipping checklist been completed? (6-18*c*)

h. Are safety requirements met? (chap 7)

i. If applicable, are security requirements met? (chap 8)

j. Are special shipping paper requirements met? (12-3)

k. Have necessary railcar inspections been made? (12-4)

l. Are loading and handling requirements met? (12-5)

m. Is package location proper? (12-6)

n. Have appropriate surveys been accomplished? (12-7)

o. If applicable, have special requirements for fissile materials been met? (12-8)

p. If applicable, have appropriate actions for accidents/incidents involving leakage been accomplished? (12-9)

CHAPTER 13
WATER MOVEMENT

Section I. GENERAL

13-1. Purpose and Scope

This chapter outlines specific regulatory and procedural requirements that apply to movement of radioactive materials by vessel. Except as provided in 49 CFR 176.5, this chapter applies to shipments on domestic or foreign vessels when in the navigable waters of the United States. This application is regardless of the vessel's character, tonnage, size, or service; whether self-propelled; and whether arriving, departing, underway, moored, anchored, aground, or in drydock.

13-2. Organization and Use

Section II contains regulatory and procedural requirements not listed elsewhere in this manual. Section III contains user checklists referenced to water (vessel) movement regulatory and procedural requirements contained in this and other chapters of this manual.

Section II. REGULATORY AND PROCEDURAL REQUIREMENTS

13-3. ITO Coordination Responsibilities

The transportation officer at the shipping installation will, upon receipt of a shipping directive:

a. Place request for ocean transportation from a CONUS port with the appropriate area commander, MTMC according to chapter 18, section V, AR 55-355. See chapters 7 and 8 of this manual for procedures and responsibilities that apply to the use of military guards and/or technical escorts.

b. Prepare REPSHIP for electrical transmission to the appropriate area commander, MTMC for CONUS port movements (para 5-25).

c. Prepare the transportation control and movement documents (TCMDs) according to DOD 4500.32R, chapter 4, section II, and appendix F.

13-4. MTMC Area Commander Responsibilities

The appropriate area commander, MTMC will:

a. Furnish the transportation officer at the shipping installation with vessel name, date shipment is required in port, and a tentative movement schedule. An information copy of all messages will be furnished to Headquarters, MTMC, ATTN: MT-SS.

b. Furnish routing instructions according to AR 55-355.

c. Consider obtaining space for the shipment of radioactive materials other than weapons in USNS vessels (MSC) and, if these are not reasonably available, consider US-flag commercial vessels.

d. Before loading and unloading radioactive materials other than weapons, particularly materials in heavily shielded metal casks, *check the slings to be used, and use only those capable of lifting five times the weight of the cask (container) and its contents.*

e. Check the latest cargo gear certificate of inspection to determine its validity, and inspect the ship's gear or crane to be used for handling this material to determine its condition. If components of cargo falls, purchases, and guys show evidence of wear, the master of this ship will be requested to renew them through the MSC or the ship's representative. Certification of this action will be made by the transportation officer, and this certificate will become part of the shipping documents.

f. Handle and stow the material according to regulatory requirements (para 13-7). Due diligence will be exercised by all concerned to ensure safe handling, stowage, and securing of this material.

13-5. Shipping Paper Requirements (49 CFR 176.24 and 176.27)

A carrier may not transport radioactive materials by vessel unless the materials are properly described on the shipping papers and carry the required certification. Papers and certification will be according to

49 CFR 172.200 through 204 (paras 5-18 through 5-21, and 5-24).

13-6. Damaged or Leaking Packages (49 CFR 176.50)

A carrier may not transport by vessel any package that is so damaged that its contents appear to have leaked or that gives evidence of failure to properly contain the contents. A package containing radioactive materials (other than low specific activity materials) may not be repaired or restored.

13-7. General Handling and Stowage Requirements (49 CFR 176.57, 176.58, 176.63, and 176.72)

a. Hazardous materials may be handled or stowed on board a vessel only under the direction and observation of a qualified person assigned for this duty. The ship's chief officer should also be present when the cargo is loaded/discharged. Requirements for qualification are contained in 49 CFR 176.57.

b. Each hold or compartment in which hazardous materials are to be transported must be swept clean of all debris before the hazardous materials are stowed therein. Bilges must be examined and all residues of previous cargo removed.

c. The hazardous materials table (49 CFR 172.101) generally specifies the locations authorized for stowage of radioactive materials aboard vessels. Additional specific requirements for stowage of radioactive materials onboard vessels are prescribed in 49 CFR 176.

d. A metal bale hook may not be used for handling any package of radioactive materials.

e. Equipment designed to lift or move cargo by means of pressure exerted on the package may not be used for handling any package of radioactive materials if the device can damage the package or the package is not designed to be moved in that manner.

f. Pallets, slings, cargo nets, and other related equipment used in loading packages of radioactive materials must give adequate support to the packages. The packages must be contained so that they cannot fall during loading.

13-8. Segregation From Other Materials (49 CFR 176.83 and 176.700)

a. Segregation from other classes of hazardous materials is to be accomplished according to table 13-1. The terms "away from" and "separated from" are as defined in 49 CFR 176.83.

b. Each package or container bearing radioactive white or radioactive yellow labels and being transported on a vessel must be stowed separately from any living accommodations and from any space continuously occupied by any person. Figure 13-1 provides segregation distances for radioactive material in ships. Stowage separate from a space occupied by a courier especially authorized to accompany a shipment is not required.

Table 13-1. Segregation Requirements Between Radioactive Materials and Designated Other Hazardous Materials

Designated hazardous	Segregation required from radioactive material
Explosives	Separated from
Flammable compressed gas	Separated from
Nonflammable compressed gas	Away from
Flammable or combustible liquids	Separated from
Flammable solids (all)	Separated from
Oxidizers	Away from
Organic peroxides	Separated from
Class A poisons	Away from
Class B poisons or irritating materials	None specified
Corrosive materials	Separated from
Other regulated materials (ORM)	None specified

SEGREGATION DISTANCES FOR RADIOACTIVE MATERIALS IN SHIPS (in feet)

	MINIMUM DISTANCE IN FEET FROM LIVING ACCOMMODATION OR REGULARLY OCCUPIED WORKING SPACE		MINIMUM DISTANCE IN FEET FROM UNDEVELOPED FILM AND PLATES																							
LENGTH OF VOYAGE	ANY LENGTH		1 DAY VOYAGE			2 DAY VOYAGE			4 DAY VOYAGE			10 DAY VOYAGE			20 DAY VOYAGE			30 DAY VOYAGE			40 DAY VOYAGE			50 DAY VOYAGE		
"CARGO OF UNIT DENSITY" THICKNESS IN FEET	Nil	3	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6
Sum of transport indexes of the packages																										
0.1 to 0.5	5	X	6	X	X	8	X	X	11	X	X	17	4	X	25	6	X	30	7	X	35	8	X	39	9	X
0.6 to 1	6	X	8	X	X	11	X	X	16	4	X	25	6	X	35	8	X	42	10	X	50	12	X	55	13	X
1.1 to 2	9	X	11	X	X	16	4	X	22	5	X	35	8	X	50	12	X	61	14	X	70	17	X	78	19	X
2.1 to 3	10	X	14	X	X	19	5	X	27	6	X	42	10	X	61	14	X	74	18	X	86	20	X	96	23	X
3.1 to 5	13	X	17	4	X	25	6	X	35	8	X	55	13	X	78	19	X	96	23	X	110	26	X	124	29	7
5.1 to 10	19	4	25	6	X	35	8	X	50	12	X	78	19	X	110	26	X	135	33	8	155	37	9	175	42	10
10.1 to 20	26	6	35	8	X	50	12	X	69	17	X	110	26	X	155	37	9	190	46	11	220	53	13	250	59	14
20.1 to 30	32	8	43	10	X	61	14	X	85	20	X	135	32	8	190	45	11	235	56	13	270	65	16	305	72	17
30.1 to 50	42	10	55	13	X	78	19	X	110	26	X	175	42	10	245	58	14	300	73	17	350	84	20	390	94	22
50.1 to 100	59	14	78	19	X	110	26	X	155	37	9	245	59	14	350	82	20	430	105	24	515	118	28	550	130	32
100.1 to 150	72	17	96	23	X	135	32	8	190	46	11	300	72	17	425	100	24	525	125	30	600	145	35	(7)	165	39
150.1 to 200	84	20	110	26	X	155	37	9	200	53	13	350	84	20	490	115	28	600	140	35	(7)	165	40	(7)	190	45
200.1 to 300	105	24	135	32	X	190	46	11	270	64	15	425	105	25	600	115	35	(7)	180	42	(7)	205	49	(7)	230	55
300.1 to 400	120	28	160	37	9	220	53	13	310	75	18	500	120	28	(7)	165	40	(7)	205	49	(7)	235	57	(7)	265	63

NOTE

(1) X—INDICATES THAT THICKNESS OF SCREENING CARGO IS SUFFICIENT WITHOUT ANY ADDITIONAL SEGREGATION DISTANCE.

(2) BY USING 6 FEET OF INTERVENING UNIT DENSITY CARGO FOR PERSONS AND 10 FEET FOR FOR FILM AND PLATES, NO DISTANCE SHIELDING IS NECESSARY FOR ANY LENGTH OF VOYAGE SPECIFIED.

(3) USING 1 STEEL BULKHEAD OR STEEL DECK—MULTIPLY SEGREGATION DISTANCE BY 0.8. USING 2 STEEL BULKHEADS OR STEEL DECKS—MULTIPLY SEGREGATION DISTANCE BY 0.64.

(4) "CARGO OF UNIT DENSITY" MEANS CARGO STOWED AT A DENSITY OF 1 TON (LONG) PER 36 CUBIC FEET; WHERE THE DENSITY IS LESS THAN THIS THE DEPTH OF CARGO SPECIFIED MUST BE INCREASED IN PROPORTION.

(5) "MINIMUM DISTANCE" MEANS THE LEAST IN ANY DIRECTION WHETHER VERTICAL OR HORIZONTAL FROM THE OUTER SURFACE OF THE NEAREST PACKAGE.

(6) THE TOTAL CONSIGNMENT ON BOARD AT ANY TIME MUST NOT EXCEED TRANSPORT INDEXES TOTALLING 200 EXCEPT IF CARRIED UNDER THE PROVISIONS OF 49 CFR 176.704(f). THE FIGURES BELOW THE DOUBLE LINE OF THE TABLE SHOULD BE USED IN SUCH A CONTINGENCY.

(7) NOT TO BE CARRIED UNLESS SCREENING BY OTHER CARGO AND BULKHEADS CAN BE ARRANGED IN ACCORDANCE WITH THE OTHER COLUMNS.

Figure 13-1. 49 CFR 176.708 Segregation distance table.

c. Mailbags may not be stowed in the same hold with radioactive materials.

d. Household goods may not be stowed in the same hold or compartment with radioactive materials.

e. The following requirements apply to the stowage of packages of radioactive materials aboard a vessel with regards to transport indexes, which are shown on the labels of individual packages:

(1) The sum of the transport indexes of any group of packages may not exceed 50. Each group of packages must be separated by at least 20 feet from all other packages bearing radioactive yellow labels. This separation requirement does not apply to low specific activity or to a full load if the consignor has exclusive use of the entire vessel and if the sum of the transport indexes of any group of Fissile Class II packages does not exceed 50.

(2) The sum of the transport indexes of all packages of radioactive materials onboard a vessel may not exceed 200.

(3) Packages bearing radioactive yellow labels may not be stowed any closer to persons or undeveloped film than distances specified in figure 13-1.

f. A package of radioactive materials which, in still air, has a surface temperature more than 5°C (9°F) above the ambient air may not be over-stowed with any other cargo. If the package is stowed under deck, the hold or compartment in which it is stowed must be ventilated.

g. A person may not remain unnecessarily in a hold compartment or on deck near any package containing radioactive materials. A person may not be exposed to a total of more than 100 millirem in any 7-day period or more than 500 millirems per year, whole body dose.

h. The radiation level in any space of areas continuously occupied by passengers, crew, or shipments of animals may not exceed 0.5 millirem per hour.

i. If a shipment of radioactive materials requires supplemental operation procedures, the shipper shall furnish the master or person in charge of the vessel a copy of the necessary operational instructions.

j. Any material listed in "The Hazardous Materials" table of 49 CFR 172.101, of which its storage requirements are listed in column 7 as "on deck," may be stowed "under deck" on an unmanned barge. (49 CFR 176.98)

13-9. Special Requirements for Fissile Radioactive Material (49 CFR 176.700)

Each Fissile Class III shipment must be stowed in a separate hold or compartment and must be stowed and handled at least 20 feet from all other packages bearing radioactive yellow labels.

13-10. Shipment of Radioactive Materials by Barge (49 CFR 176.96)

Unless otherwise approved by the Commandant, US Coast Guard (G-MTH, Washington, DC, (202) 267-2967) only barges constructed of steel are permitted to carry hazardous materials.

13-11. Care After Leakage or Sifting of Radioactive Materials (49 CFR 176.710)

a. In case of fire, collision, or breakage involving any shipment of radioactive materials, other than materials of low specific activity, the package of material must be segregated from unnecessary contact with personnel. In case of obvious leakage, or if the inside container appears to be damaged, the stowage area (hold, deck area, or compartment) containing this cargo must be isolated as much as possible to prevent radioactive material from entering any person's body through contact, inhalation, or ingestion. No person may handle the material or remain in the vicinity unless supervised by a qualified person.

b. A hold or compartment in which leakage of radioactive materials has occurred may not be used for other cargo until it is decontaminated according to the requirements of paragraph 3-12.

c. For reporting requirements, see 49 CFR 171.15 (chap 7).

13-12. Contamination Control (49 CFR 176.715)

Each hold, compartment, or deck area used for the transport of low specific activity radioactive material as a full load must be surveyed with appropriate radiation detection instruments, after each use. It may not be used again until the radiation dose rate at any accessible surface is less than 0.5 millirem per hour and there is no significant removable radioactive surface contamination remaining (paras 3-9 and 3-10).

Section III. WATER MOVEMENT CHECKLIST

13-13. Use of Checklist

When a shipment of radioactive materials by vessel is planned or moved, the following checklist can be used as an aid to assure that all required considerations are accomplished. The checklist consists of a series of questions, each requiring a yes answer. Necessary actions to allow a yes answer to each question should be completed to assure that a shipment meets the applicable criteria.

13-14. Water Movement Checklist

a. Have packaging checklists been completed? (4-25)

b. Has marking and labeling checklist been completed? (5-29)

c. Has placarding checklist been completed? (5-30)

d. Has documentation checklist been completed? (5-31)

e. Has general planning checklist been completed? (6-18*a*)

f. If applicable, has receiving and unloading checklist been completed? (6-18*b*)

g. Have appropriate parts of general shipping checklist been completed? (6-18*c*)

h. Are safety requirements met? (chap 7)

i. If applicable, are security requirements met? (chap 8)

j. Have ITO coordination responsibilities been completed? (13-3)

k. Are shipping paper requirements met? (13-5)

l. Are damaged or leaking package requirements met? (13-6)

m. Are handling and stowage requirements met? (13-7)

n. Have segregation requirements been met? (13-8)

o. If applicable, are special requirements for fissile materials met? (13-9)

p. If applicable, is the shipment allowed on the barge class intended? (13-10)

q. If applicable, have proper actions for care following leakage or sifting been taken? (13-11)

CHAPTER 14
THE UNITED STATES POSTAL SERVICE MOVEMENT

Section I. GENERAL

14-1. Purpose and Scope

This chapter outlines specific regulatory and procedural requirements that apply to movement of radioactive materials by the US Postal Service. Any package of radioactive materials that must be labeled Radioactive White-I, Radioactive Yellow-II, or Radioactive Yellow-III or that contains quantities of radioactive material in excess of those authorized in section II is non-mailable. (USPS Publication 6)

14-2. Organization and Use

Section II contains the authorized quantities of radioactive materials that may be shipped by USPS. Section III contains user checklists referenced to the USPS movement regulatory and procedural requirements contained in this and other chapters of this manual.

Section II. REGULATORY AND PROCEDURAL REQUIREMENTS

14-3. Mailable Radioactive Materials

Mailable radioactive materials include only those that are classified as limited quantities of radioactive materials; excepted instruments, articles, and devices; or excepted articles containing natural uranium or thorium as prescribed in 49 CFR 173.421, 174.422, or 173.424, provided the activity content of any package, instrument, or article does not exceed the activity limits stated in table 4-7 (49 CFR 173.423). (USPS Publication 6)

a. Limited Quantities (49 CFR 173.421). Radioactive materials whose activity per package does not exceed the limits specified in table 4-7 are excepted from specification packaging, marking, and labeling requirements if:

(1) The materials are packaged in strong, tight packages that will not leak any of the radioactive materials during normal postal handling. Liquid radioactive materials must be packaged also within a leak-resistant and corrosion-resistant secondary inner container, surrounded by enough suitably positioned absorbent material to absorb at least twice the volume of the liquid contents in the event of leakage from the secondary inner container;

(2) The radiation level at any point on the external surface of the package does not exceed 0.5 millirem per hour;

(3) The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in 49 CFR 173.443(a);

(4) The outside of the inner packaging or, if no inner packaging, the outside of the packaging itself is marked Radioactive;

NOTE

Do not confuse the radioactive marking on the packaging with the requirement of paragraph 14-8, which states that no identification marks are authorized on the external addressed covering of the package.

(5) Except as provided in 49 CFR 173.424, the package does not contain more than 15 grams of uranium-235; and

(6) No single dimension less than 2.5 centimeters (1 inch) and the length and girth no less than 30 centimeters (12 inches).

b. Instruments and Articles (49 CFR 173.422). Instruments and manufactured articles (including clocks, electronic tubes, or apparatus), or similar devices having radioactive materials in gaseous or nondispersible solid form and a component part, are excepted from specification packaging, marking, and labeling requirements if:

(1) The activity of the instrument or device does not exceed the relevant limits listed in table 4-7 (49 CFR 173.423);

(2) The total activity per package does not exceed the relevant limits listed in table 4-7;

(3) The radiation level at 10 centimeters (4 inches) from any point on the external surface of any unpackaged instrument or device does not exceed 10 millirems per hour;

(4) The radiation level at any point on the external surface of the package bearing the device or instrument does not exceed 0.5 millirem per hour, or for exclusive-use domestic shipments, 2 millirems per hour;

(5) The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limit specified in 49 CFR 173.443(a);

(6) Except as provided in 49 CFR 173.424, the package does not contain more than 15 grams of uranium-235;

(7) At least one external dimension of the package is not less than 10 centimeters (4 inches); and

(8) The outside of the inner packaging or, if no inner packaging, the outside of the packaging itself is marked Radioactive. (See note in para 14-1*a*(4) above.)

c. Table of Activity Limits for Limited Quantities, Instruments, and Articles (49 CFR 173.423). The limits applicable to instruments, devices, and limited quantities subject to exceptions under 49 CFR 173.421 and 49 CFR 173.422 are shown in table 4-7.

d. Excepted Articles Containing Uranium or Thorium (49 CFR 173.424). Manufactured articles in which the sole radioactive material content is natural or depleted uranium or natural thorium are excepted from specification packaging, marking, and labeling requirements if:

(1) The outer surface of the uranium or thorium is enclosed in an inactive sheath of metal or other protective material; and

(2) The conditions specified in 49 CFR 173.421 (b), (c), and (d) are met.

14-4. Air Transport Requirements

Shipment by passenger aircraft is restricted to radioactive material intended for use in, or incident to, research, medical diagnosis, or treatment. All other radioactive material is NONMAILABLE by passenger aircraft through the US Postal Service. However, per chapter 10 of this manual, larger shipments of radioactive material may be shipped by air, but not through the US Postal Service.

14-5. International Mail Requirements

Shipments containing radioactive materials are mailable through international mails if the following provisions are met:

a. Radioactive shipments must be sent in a registered airmail letter package.

b. Shipments must comply with both the International Atomic Energy Agency Regulations and the packaging specifications outlined in this chapter.

c. Senders and recipients of radioactive materials must receive prior authorization from the appropriate regulatory authorities within their countries.

d. A white package label bearing the French words "MATIERES RADIOACTIVES" (Radioactive Materials) must be taped or gummed to the address side of each package containing radioactive materials. Senders are responsible for supplying and affixing this label to the package wrapper.

e. Package wrappers must bear the following endorsement in bold letters: "Return to Sender in Case of Nondelivery."

f. Radioactive materials may be sent only to those countries of the Universal Postal Union that have expressed a willingness to accept packages containing radioactive materials. (See the particular country of interest in the *International Mail Manual* under the "Prohibition and Restrictions" section for postal union mail.)

14-6. Nonmailable Radioactive Materials

The following shipments are NONMAILABLE through the US Postal Service.

a. Any package bearing one of the Department of Transportation labels shown in chapter 5 of this manual.

b. All radioactive materials except those that are outlined in paragraph 14-3 of this manual.

14-7. Packaging for the USPS

Besides the packaging specifications listed in chapter 4 of this manual, packages addressed from, to, or between overseas military post offices must, as a minimum, be packed in containers equivalent to the fiberboard boxes, wood, metal, or plastic containers as specified in the *Domestic Mail Manual*, section 121.

14-8. Package Markings (DMM 124.21)

Except as specified in paragraph 14-5*d* above, identification markings on the external surface of the package to be mailed, which identifies the contents of any package containing radioactive material, are unauthorized.

14-9. Size and Weight Limitations

Each package may not weigh more than 70 pounds or have a combined length and girth of greater than 108 inches. To compute the combined length and girth, measure the longest side and the distance

around the package at its thickest part (girth), then add both measurements.

NOTE

Sometimes, packages sent to, through, or from military post offices outside the 48 contiguous States are mailed at "surface postage rates," which require the package to be qualified for "space available mail" (SAM). A SAM package has smaller size and weight limits than outlined in paragraph 14-9 above. However, per paragraph 14-5*a* above, all international mail shipments of radioactive materials must be sent in a registered, first-class airmail package.

Section III. USPS MOVEMENT CHECKLIST

14-10. Use of Checklist

When a shipment of radioactive materials by the USPS is planned or mailed, the following checklist can be used as an aid to assure that all required considerations are completed. The checklist consists of a series of questions, each of which requires a yes answer. Necessary actions to allow a yes answer to each question should be carried out to assure that a shipment meets the applicable criteria.

14-11. USPS Movement Checklist

a. Have packaging checklists been completed? (4-25 & 14-7)

b. Is the package exempt from the requirement of being labeled Radioactive White-I, Radioactive Yellow-II, or Radioactive Yellow-III? (5-29)

c. Is the package of radioactive material within the limits of "Limited Quantities?" (14-3*a*)

d. If applicable, is the instrument or article excepted from specification packaging, marking, and labeling requirements? (14-3*b* and *c*)

e. If the package contains uranium or thorium, is it an excepted article? (14-3*d*)

f. Does the package of radioactive material meet all the requirements of "Mailable Radioactive Materials"? (14-3)

g. Is the package exempt from the list of nonmailable radioactive materials? (14-6)

h. If the package is being shipped by airmail, does it meet the airmail requirements? (14-4)

i. If the package is to be mailed internationally, does it meet the requirements of international mail? (14-5)

j. If the package is to be mailed internationally, does it also meet airmail requirements per paragraph 14-4? (14-5*a*)

k. If the package is to be mailed internationally, does the addressed country of receipt accept packages of radioactive mail? (14-5*f*)

l. Does the package meet the postal service size and weight limitations? (14-9)

APPENDIX A
REFERENCES

1. Army Regulations (AR)

40-13	Radiological Emergency Medical Teams
40-14	Control and Recording Procedures Occupational Exposure to Ionizing Radiation
50-2	Nuclear Weapon Accident and Incident Control (NAIC)
50-5	Nuclear Surety
55-16	Movement of Cargo by Air and Surface Including Less than Release Unit and Parcel Post Shipments
55-38	Reporting of Transportation Discrepancies in Shipments
55-162	Permits for Oversize, Overweight, or Other Special Military Movements on Public Highways in the Contiguous States and District of Columbia of the United States
55-203	Movement of Nuclear Weapons, Nuclear Components, and Related Classified Nonnuclear Material
55-228	Transportation by Water of Explosives and Hazardous Cargo
55-355	Defense Traffic Management Regulation – Transportation Facility Guide, Army
59-8	Military Airlift Command – Requirement Submissions, Space Assignments and Allocations, and Procedures
59-9	Special Assignment Airlift Mission Requirements Submission Procedures
95-27	Operational Procedures for Aircraft Carrying Hazardous Materials
310-25	Dictionary of United States Army Terms (short Title: AD)
310-50	Authorized Abbreviations, Brevity Codes, and Acronyms
360-5	Army Public Affairs – Public Information
380-55	Safeguarding Defense Information in Movement of Persons and Things
385-10	Army Safety Program
385-11	Safety: Ionizing Radiation Protection

385-14	Accident Reporting Procedures, Army-Shipped Nonnuclear Explosives and Dangerous Articles Transported by Commercial Carriers
385-30	Safety Color Code Markings and Signs
385-40	Accident Reporting and Records
70-47	Engineering for Transportability
700-25	Nuclear Reactors Authorization and Accounting of Utilization Facilities and Special Nuclear Material for Use Therein
700-63	Control of Radioactive Calibration and Test Items of Supply
700-64	Radioactive Commodities in the DOD Supply Systems
725-1	Special Authorization and Procedures for Issues, Sales, and Loans
735-11-2	Reporting of Item Discrepancies Attributable to Shippers
740-32	Responsibilities for Technical Escorts of Chemicals, Biological, and Etiological Agents

2. DOD Regulations

4500.32-R	Military Standard Transportation and Movement Procedures

3. Army Technical Manuals (TM)

3-220	Chemical, Biological, and Radiological Decontamination
3-261	Handling and Disposal of Unwanted Radioactive Material
38-250	Packaging and Handling of Dangerous Materials for Transportation by Military Aircraft
55-4470-400-12-1	Transportability Guidance for Nuclear Reactor Irradiated Fuel Elements

4. Army Field Manuals (FM)

3-15	Nuclear Accident Contamination Control

5. Miscellaneous

MIL-STD-129H Marking for Shipment and Storage
Bureau of Explosives Tariff BOE 6000-A
Title 49, CFR, 171-178, Hazardous Materials Regulations
Title 10, CFR, 20, Standards for Protection Against Radiation
Title 10, CFR, 70, Special Nuclear Material
Title 10, CFR, 71, Packaging of Radioactive Material for Transport
Title 10, CFR, 73, Physical Protection of Plants and Materials
Official Air Transport Restricted Articles Tariff No. 6-Series Agent C.C. Squire, General Manager
United Nations, International Atomic Energy Agency Regulations for the Safe Transport of Radioactive Materials, Notes on Certain Aspects of the Regulations, Safety Series No.7
MTMTS Pam 55-2 Guidelines on Stuffing Containers
MTMTS Pam 55-3 Guidelines on Transportation Security
United States Postal Service Publication 52, Acceptance of Hazardous or Perishable Articles
Domestic Mail Manual 124.37, Radioactive Materials
United States Postal Service Publication 6, Radioactive Materials

By Order of the Secretary of the Army:

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